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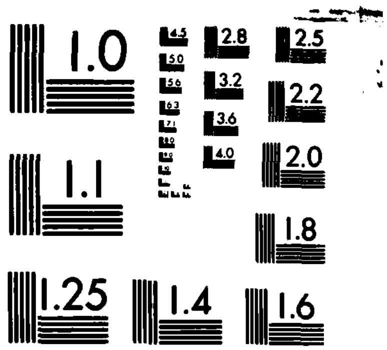

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USER GUIDE FOR WIFM-SAL: A TWO-DIMENSIONAL VERTICALLY INTEGRATED, TIME-VARYING ESTUARINE TRANSPORT MODEL

by

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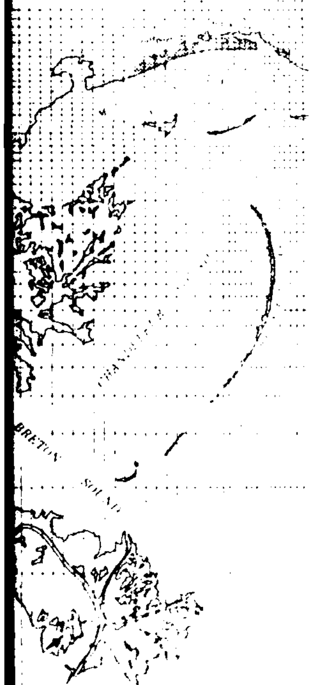

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WIFM-SAL is preliminary to the development of comprehensive water quality models that may be used to assist in the analysis of water quality problems in shallow estuaries and embayments which may be considered vertically well mixed. The model is two dimensional in the horizontal and generates time-varying water surface elevations, velocities, and constituent fields over a space staggered grid. Units of measure are expressed in the English system (slug-ft-second).

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20. ABSTRACT (Continued).

Results computed on a global grid may be employed as boundary conditions on a more spatially limited refined grid concentrated around the area of interest. In addition, the user may select either of two distinct transport schemes. Scheme 1 is a flux-corrected transport scheme capable of resolving sharp fronts without oscillation. Scheme 2 is a full, three time level scheme directly compatible with the three time level hydrodynamics. The telescoping grid capability in conjunction with the user selectable constituent transport scheme is an extremely powerful concept in real world transport problem solving. Additional keywords: WIFM (WES Implicit Flooding Model); WES (Waterways Experiment Station); Computerized Simulation; Salinity; Subroutines; Input; output.

PREFACE

This report describes the development and application of a numerical transport model used as a basis for 2-D vertically averaged estuarine water quality models. The preparation of this report was sponsored by the Office, Chief of Engineers (OCE), under the Environmental Impact Research Program (EIRP). The Mobile District, CE, sponsored the Mississippi Sound Study, which is presented as a test application. Technical Monitors for EIRP were Dr. John Bushman and Mr. Earl Eiker of OCE and Mr. David B. Mathis, U. S. Army Water Resources Support Center.

The work presented in the report was conducted from July 1979 through June 1983 in the Wave Dynamics Division (WDD) of the Hydraulics Laboratory (HL) of the U. S. Army Engineer Waterways Experiment Station (WES) under the general supervision of Messrs. H. B. Simmons, Chief, HL, and Claude E. Chatham, Jr., Acting Chief, WDD. The WDD was transferred to the Coastal Engineering Research Center (CERC) of WES on 1 July 1983. From July through September 1983, work was performed in the WDD of CERC under the general supervision of Dr. R. W. Whalin, Chief, CERC, and Mr. Chatham, Chief, WDD. Dr. R. A. Schmalz, Jr., WDD, conducted the Mississippi Sound Study and prepared this report.

The preparation of this report was monitored by Mr. Ross W. Hall, Ecosystem Research and Simulation Division (ERSD), Environmental Laboratory (EL), under the general supervision of Mr. Don L. Robey, Chief, ERSD, and Dr. John Harrison, Chief, EL. Program Manager at WES for EIRP was Dr. Roger T. Saucier.

Commanders and Directors of WES during the conduct of this study and the preparation and publication of this report were COL Nelson P. Conover, CE, and COL Tilford C. Creel, CE. Technical Director was Mr. F. R. Brown.

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CONTENTS

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI)
UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
feet	0.3048	metres
feet per second	0.3048	metres per second
miles per hour (U. S. statute)	1.609347	kilometres per hour

USER GUIDE FOR WIFM-SAL: A TWO-DIMENSIONAL VERTICALLY INTEGRATED, TIME-VARYING ESTUARINE TRANSPORT MODEL

PART I: CAPABILITIES AND LIMITATIONS

1. The transport model WIFM-SAL was developed as a prerequisite requirement for water quality models to be used in the analysis of water quality problems in shallow estuaries and embayments which may be considered vertically well mixed thereby justifying a vertically integrated approach. The model is two-dimensional in the horizontal and generates time-varying water surface elevations, velocities, and constituent fields over a space staggered grid. Units of measure are expressed in the English system (slug-foot-second).

2. Two constituent transport schemes have been incorporated in the U. S. Army Engineer Waterways Experiment Station (WES) Implicit Flooding Model (WIFM) developed by Butler (1980). Constituent computations are performed at the same time step interval as employed in the hydrodynamic computations. Therefore, if desired, the user may develop the coding necessary to density couple the hydrodynamics if this is important for the problem of concern. Density coupling is not implemented in the model at this time.

3. An exponentially stretched grid system is used in WIFM-SAL allowing the user to increase resolution in specific areas where more computational detail is desired. This feature is particularly useful in modeling inlets and barrier island systems.

4. Since the constituent transport schemes are directly encoded within WIFM, this model must be used to provide the hydrodynamic description. Future work will be conducted to develop a separate transport-dispersion model, allowing for user selectable hydrodynamic input and transport scheme selection.

5. Although WIFM has been used extensively in moving boundary applications, the transport schemes assume a fixed land/sea boundary. Future work is needed to remove this restriction.

6. The constituent transport equation considered is for a passive scalar without source/sink terms. The extension to multiple (reacting) constituent systems remains to be developed.

7. WIFM-SAL allows the model user to employ results computed on a global grid as boundary conditions on a more spatially limited, refined grid

concentrated around the area of interest. In addition, the user may select either of two distinct transport schemes. Scheme 1 is a flux-corrected transport scheme capable of resolving sharp fronts without oscillation. Scheme 2 is a full, three time level scheme directly compatible with the three time level hydrodynamics. Scheme 1 requires approximately three times more computer time than scheme 2 but is more accurate than scheme 2 for sharp front problems.

8. However, on a coarse spatial resolution global grid covering a large area, scheme 2 results may be used in areas away from sharp fronts to provide boundary conditions for a more refined grid system encompassing the sharp front region of propagation. Scheme 1 may then be selected to resolve the sharp front over this refined grid. Thus, the telescoping grid capability in conjunction with the user selectable constituent transport scheme is an extremely powerful concept in real world transport problem solving.

PART II: THEORETICAL DEVELOPMENTS

9. Consider the instantaneous three-dimensional constituent transport equation. The time scales for which this equation applies are of much shorter duration than can be modeled. Therefore, the instantaneous equation is temporally averaged. Under the vertically integrated approach, the resulting equation is then depth averaged. The transport equation obtained is then transformed using an exponential stretch. Numerical approximations to the transformed equation are formulated followed by the development of relations for the effective dispersion coefficients.

Constituent Transport Equation in Cartesian Coordinates

10. The instantaneous constituent transport equation is

$$\frac{\partial s}{\partial t} + u \frac{\partial s}{\partial x} + v \frac{\partial s}{\partial y} + w \frac{\partial s}{\partial z} = \frac{\partial}{\partial x}\left(D_x \frac{\partial s}{\partial x}\right) + \frac{\partial}{\partial y}\left(D_y \frac{\partial s}{\partial y}\right) + \frac{\partial}{\partial z}\left(D_z \frac{\partial s}{\partial z}\right) \tag{1}$$

where

$x,y,z \equiv$ Cartesian coordinates

$u,v,w \equiv$ velocity components in the x- , y- , and z-directions, respectively

$t \equiv$ time

$s \equiv$ concentration of the material of concern

$D_x \equiv$ molecular diffusion coefficient in the x-direction

$D_y \equiv$ molecular diffusion coefficient in the y-direction

$D_z \equiv$ molecular diffusion coefficient in the z-direction

For a turbulent flow, the turbulent diffusion is much greater than the molecular diffusion. The following analogous formula holds where time averaging over the time scale of the turbulence has been performed.

$$\frac{\partial s}{\partial t} + u \frac{\partial s}{\partial x} + v \frac{\partial s}{\partial y} + w \frac{\partial s}{\partial z} = \frac{\partial}{\partial x}\left(K_x \frac{\partial s}{\partial x}\right) + \frac{\partial}{\partial y}\left(K_y \frac{\partial s}{\partial y}\right) + \frac{\partial}{\partial z}\left(K_z \frac{\partial s}{\partial z}\right) \tag{2}$$

where K_x, K_y, and K_z are turbulent diffusion coefficients. Equation 2 may be written in conservation form by adding s times the continuity equation (namely, zero) to the left-hand side to obtain

$$\frac{\partial s}{\partial t} + \frac{\partial (us)}{\partial x} + \frac{\partial (vs)}{\partial y} + \frac{\partial (ws)}{\partial z}$$

$$= \frac{\partial}{\partial x}\left(K_x \frac{\partial s}{\partial x}\right) + \frac{\partial}{\partial y}\left(K_y \frac{\partial s}{\partial y}\right) + \frac{\partial}{\partial z}\left(K_z \frac{\partial s}{\partial z}\right) \qquad (3)$$

This form of the equation is then depth integrated as described in Schmalz (1981a) to obtain:

$$\frac{\partial}{\partial t}(hs) + \frac{\partial}{\partial x}(hus) + \frac{\partial}{\partial y}(hvs) = \frac{\partial}{\partial x}\left(hK_x^* \frac{\partial s}{\partial x}\right) + \frac{\partial}{\partial y}\left(hK_y^* \frac{\partial s}{\partial y}\right) \qquad (4)$$

where h is the water depth and K_x^* and K_y^* are effective dispersion coefficients.

Constituent Transport Equation in Transformed Coordinates

11. The transport equation is transformed from x - y space to $\alpha_1 - \alpha_2$ space by means of the following coordinate transformation as considered by Butler (1980).

$$x = a_1 + b_1\alpha_1^{c_1} \rightleftharpoons \alpha_1 = \left(\frac{x - a_1}{b_1}\right)^{1/c_1} \qquad (5)$$

$$y = a_2 + b_2\alpha_2^{c_2} \rightleftharpoons \alpha_2 = \left(\frac{y - a_2}{b_2}\right)^{1/c_2} \qquad (6)$$

The terms a_1, b_1, c_1, a_2, b_2, and c_2 are constants valid for different regions in the grid. Then for an arbitrary hydrodynamic variable $\rho(x,y,t)$

$$\frac{\partial \rho}{\partial x} = \frac{\partial \rho}{\partial \alpha_1}\frac{d\alpha_1}{dx} \qquad \frac{\partial \rho}{\partial y} = \frac{\partial \rho}{\partial \alpha_2}\frac{d\alpha_2}{dy} \qquad (7)$$

$$\frac{\partial^2\rho}{\partial x^2} = \frac{\partial}{\partial\alpha_1}\left(\frac{\partial\rho}{\partial x}\right)\frac{d\alpha_1}{dx} = \frac{\partial}{\partial\alpha_1}\left(\frac{\partial\rho}{\partial\alpha_1}\,\frac{d\alpha_1}{dx}\right)\frac{d\alpha_1}{dx} = \frac{d\alpha_1}{dx}\left[\frac{\partial^2\rho}{\partial\alpha_1^2}\,\frac{d\alpha_1}{dx} + \frac{\partial\rho}{\partial\alpha_1}\,\frac{\partial}{\partial\alpha_1}\left(\frac{d\alpha_1}{dx}\right)\right] \tag{8a}$$

$$\frac{\partial^2\rho}{\partial y^2} = \frac{\partial}{\partial\alpha_2}\left(\frac{\partial\rho}{\partial y}\right)\frac{d\alpha_2}{dy} = \frac{\partial}{\partial\alpha_2}\left(\frac{\partial\rho}{\partial\alpha_2}\,\frac{d\alpha_2}{dy}\right)\frac{d\alpha_2}{dy} = \frac{d\alpha_2}{dy}\left[\frac{\partial^2\rho}{\partial\alpha_2^2}\,\frac{d\alpha_2}{dy} + \frac{\partial\rho}{\partial\alpha_2}\,\frac{\partial}{\partial\alpha_2}\left(\frac{d\alpha_2}{dy}\right)\right] \tag{8b}$$

If we introduce $\mu_1 = dx/d\alpha_1$ and $\mu_2 = dy/d\alpha_2$ then

$$\frac{\partial\rho}{\partial x} = \frac{1}{\mu_1}\,\frac{\partial\rho}{\partial\alpha_1} \qquad \frac{\partial\rho}{\partial y} = \frac{1}{\mu_2}\,\frac{\partial\rho}{\partial\alpha_2} \tag{9}$$

$$\frac{\partial^2\rho}{\partial x^2} = \frac{1}{\mu_1}\left[\frac{1}{\mu_1}\,\frac{\partial^2\rho}{\partial\alpha_1^2} + \frac{\partial\rho}{\partial\alpha_1}\,\underline{\frac{\partial}{\partial\alpha_1}\left(\frac{1}{\mu_1}\right)}\right] \tag{10}$$

$$\frac{\partial^2\rho}{\partial y^2} = \frac{1}{\mu_2}\left[\frac{1}{\mu_2}\,\frac{\partial^2\rho}{\partial\alpha_2^2} + \frac{\partial\rho}{\partial\alpha_2}\,\underline{\frac{\partial}{\partial\alpha_2}\left(\frac{1}{\mu_2}\right)}\right] \tag{11}$$

Considering Equation 8a in an alternate manner

$$\frac{\partial^2\rho}{\partial x^2} = \frac{\partial}{\partial x}\left(\frac{\partial\rho}{\partial\alpha_1}\,\frac{d\alpha_1}{dx}\right) = \frac{\partial}{\partial x}\left(\frac{\partial\rho}{\partial\alpha_1}\right)\frac{d\alpha_1}{dx} + \frac{\partial\rho}{\partial\alpha_1}\,\frac{d^2\alpha_1}{dx^2} \tag{12}$$

Noting $\partial/\partial x = (\partial/\partial\alpha_1)(d\alpha_1/dx) = (\partial/\partial\alpha_1)(1/\mu_1)$

$$\frac{\partial^2\rho}{\partial x^2} = \frac{\partial^2\rho}{\partial\alpha_1^2}\left(\frac{d\alpha_1}{dx}\right)^2 + \frac{\partial\rho}{\partial\alpha_1}\,\frac{d^2\alpha_1}{dx^2} \tag{13}$$

Employing previous notation, Equation 13 is rewritten as follows:

$$\frac{\partial^2\rho}{\partial x^2} = \frac{\partial^2\rho}{\partial\alpha_1^2}\left(\frac{1}{\mu_1}\right)^2 + \frac{\partial\rho}{\partial\alpha_1}\,\frac{d}{dx}\left(\frac{1}{\mu_1}\right) \tag{14}$$

Note, however, from the relation between $\partial/\partial x$ and $\partial/\partial\alpha_1$ we obtain

$$\frac{\partial^2\rho}{\partial x^2} = \frac{\partial^2\rho}{\partial\alpha_1^2}\left(\frac{1}{\mu_1}\right)^2 + \frac{\partial\rho}{\partial\alpha_1}\frac{d}{d\alpha_1}\left(\frac{1}{\mu_1}\right)\frac{1}{\mu_1} \tag{15}$$

This relation is equivalent to Equation 8.

12. If we consider a hydrodynamic variable $\rho(\alpha_1,\alpha_2,t)$ and let i^*, j^*, n be defined such that

$$\rho^n_{i^*,j^*} = \rho(i^*\Delta\alpha_2, j^*\Delta\alpha_1, n\Delta t) \tag{16}$$

Then let i, j, n be such that

$$\rho^n_{i,j} = \rho\left[a_2 + b_2(i^*\Delta\alpha_2)^{c_2}\ ,\ \ a_1 + b_1(j^*\Delta\alpha_1)^{c_1}\ ,\ \ n\Delta t\right] \tag{17}$$

We employ uniform spacing in $\alpha_1 - \alpha_2$ space and irregular spacing in $x - y$ space. We may evaluate the derivatives with respect to x and y as follows.

$$\left.\frac{\partial\rho}{\partial x}\right|^n_{i,j} = \left.\frac{\partial\rho}{\partial\alpha_1}\right|^n_{i^*,j^*}\left.\frac{d\alpha_1}{dx}\right|_{j^*} \tag{18}$$

where

$$\frac{d\alpha_1}{dx} = \frac{1}{c_1 b_1}\left(\frac{x - a_1}{b_1}\right)^{(1-c_1)/c_1} = f(x)$$

$$f\left(a_1 + b_1\alpha_1^{c_1}\right) = \frac{1}{c_1 b_1}\alpha_1^{(1-c_1)} = f(\alpha_1) \qquad \left.\frac{d\alpha_1}{dx}\right|_{j^*} = f(j^*\Delta\alpha_1)$$

and

$$\left.\frac{\partial\rho}{\partial y}\right|^n_{i,j} = \left.\frac{\partial\rho}{\partial\alpha_2}\right|^n_{i^*,j^*}\left.\frac{d\alpha_2}{dy}\right|_{i^*} \tag{19}$$

where

$$\frac{d\alpha_2}{dy} = \frac{1}{c_2 b_2}\left(\frac{y - a_2}{b_2}\right)^{(1-c_2)/c_2} = g(y)$$

$$g\left(a_2 + b_2\alpha_2^{c_2}\right) = \frac{1}{c_2 b_2}\,\alpha_2^{(1-c_2)} = g(\alpha_2) \qquad \left.\frac{d\alpha_2}{dy}\right|_{i^*} = g(i^*\Delta\alpha_2)$$

For the second derivative term we obtain

$$\left.\frac{\partial^2\rho}{\partial x^2}\right|_{i,j}^{n} = \left.\frac{d\alpha_1}{dx}\right|_{j}\left[\left.\frac{\partial^2\rho}{\partial\alpha_1}\right|_{i^*,j^*}^{n}\left.\frac{d\alpha_1}{dx}\right|_{j} + \left.\frac{\partial\rho}{\partial\alpha_1}\right|_{i^*,j^*}^{n}\left.\frac{d}{d\alpha_1}\left(\frac{d\alpha_1}{dx}\right)\right|_{j^*}\right] \tag{20}$$

where

$$\frac{d}{d\alpha_1}\left(\frac{d\alpha_1}{dx}\right) = \frac{d}{d\alpha_1}\left[f\left(a_1 + b_1\alpha_1^{c}\right)\right] = \frac{(1 - c_1)}{c_1 b_1}\,\alpha_1^{-c_1} = h(\alpha_1)$$

$$\left.\frac{d}{d\alpha_1}\left(\frac{d\alpha_1}{dx}\right)\right|_{j^*} = h(j^*\Delta\alpha_1)$$

Similarly, for $\left.\frac{\partial^2\rho}{\partial y^2}\right|_{i,j}^{n}$. The underlined terms in Equations 10 and 11, although they may be computed exactly, are approximated using finite differencing on μ_1 and μ_2 .

13. Transforming Equation 4 in $x - y$ space to $\alpha_1 - \alpha_2$ space we obtain the following result:

$$(ds)_t + \frac{(dus)_{\alpha_1}}{\mu_1} + \frac{(dvs)_{\alpha_2}}{\mu_2} = \frac{1}{\mu_1}\left[dK_{\alpha_1}\frac{(s)_{\alpha_1}}{\mu_1}\right]_{\alpha_1} + \frac{1}{\mu_2}\left[dK_{\alpha_2}\frac{(s)_{\alpha_2}}{\mu_2}\right]_{\alpha_2} \tag{21}$$

where d is introduced as the depth in place of h

$$(\ )_t = \partial/\partial t$$

$$(\ )_{\alpha_1} = \partial/\partial \alpha_1$$

$$(\ )_{\alpha_2} = \partial/\partial \alpha_2$$

Equation 21 is the relation that is the subject of numerical approximation.

Numerical Approximations

14. Schmalz (1983a, 1983b, 1983c) considered several alternate techniques for approximating Equation 21. The Flux Corrected Transport Scheme (FCT) was selected as the most accurate scheme and has been incorporated in the Waterways Experiment Station Implicit Flooding Model (WIFM). In addition a three time level explicit transport scheme was also incorporated in the model. A space staggered grid as shown in Figure 1 was employed in all of the formulations. The datum convention is presented in Figure 2.

15. Let us introduce the following notation as a prelude to the approximations. Define for an arbitrary variable $F^k_{n,m}$, where $t = k\Delta t$, $y = n\Delta y$, $x = m\Delta x$:

$$\delta^k_t\left(F^k_{n,m}\right) = F^{k+1/2}_{n,m} - F^k_{n,m} \tag{22a}$$

$$\delta'^k_t\left(F^k_{n,m}\right) = F^{k+1}_{n,m} - F^k_{n,m} \tag{22b}$$

$$\delta_{\alpha_1}\left(F^k_{n,m}\right) = F^k_{n,m+1/2} - F^k_{n,m-1/2} \tag{22c}$$

$$\delta_{\alpha_2}\left(F^k_{n,m}\right) = F^k_{n+1/2,m} - F^k_{n-1/2,m} \tag{22d}$$

$$\overline{F}^{\alpha_1}_{n,m} = \frac{\left(F^k_{n,m+1/2} + F^k_{n,m-1/2}\right)}{2} \tag{22e}$$

$$\overline{F}^{\alpha_2}_{n,m} = \frac{\left(F^k_{n+1/2,m} + F^k_{n-1/2,m}\right)}{2} \tag{22f}$$

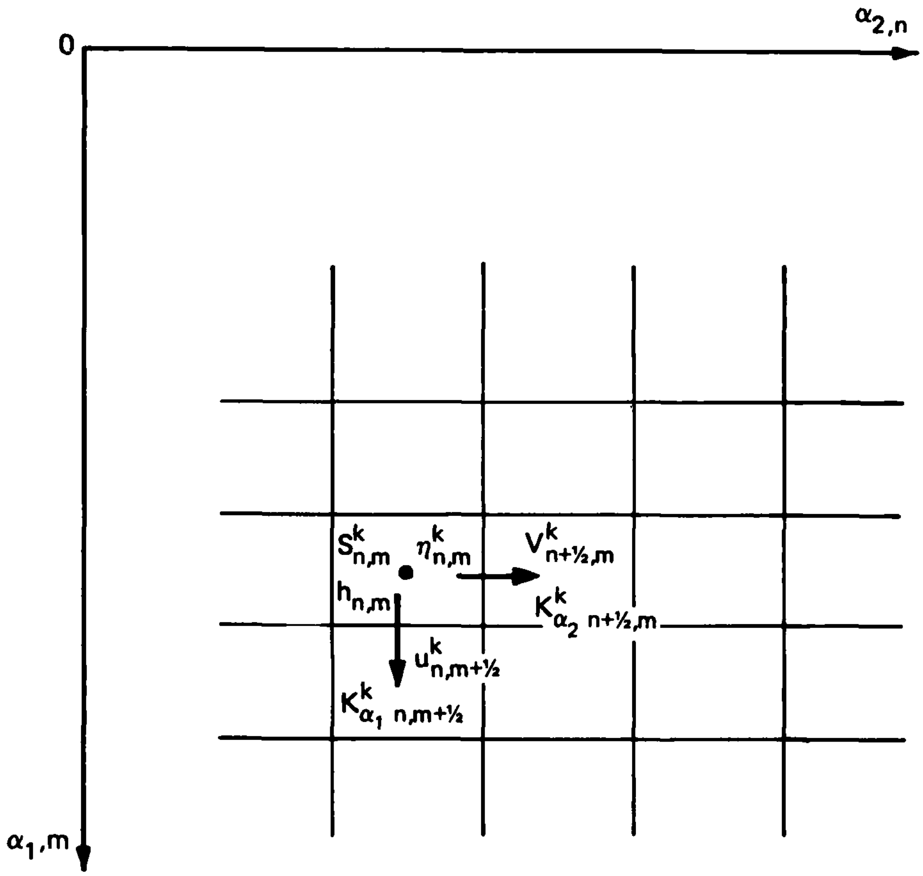

Figure 1. Space staggered finite difference grid in transformed coordinates

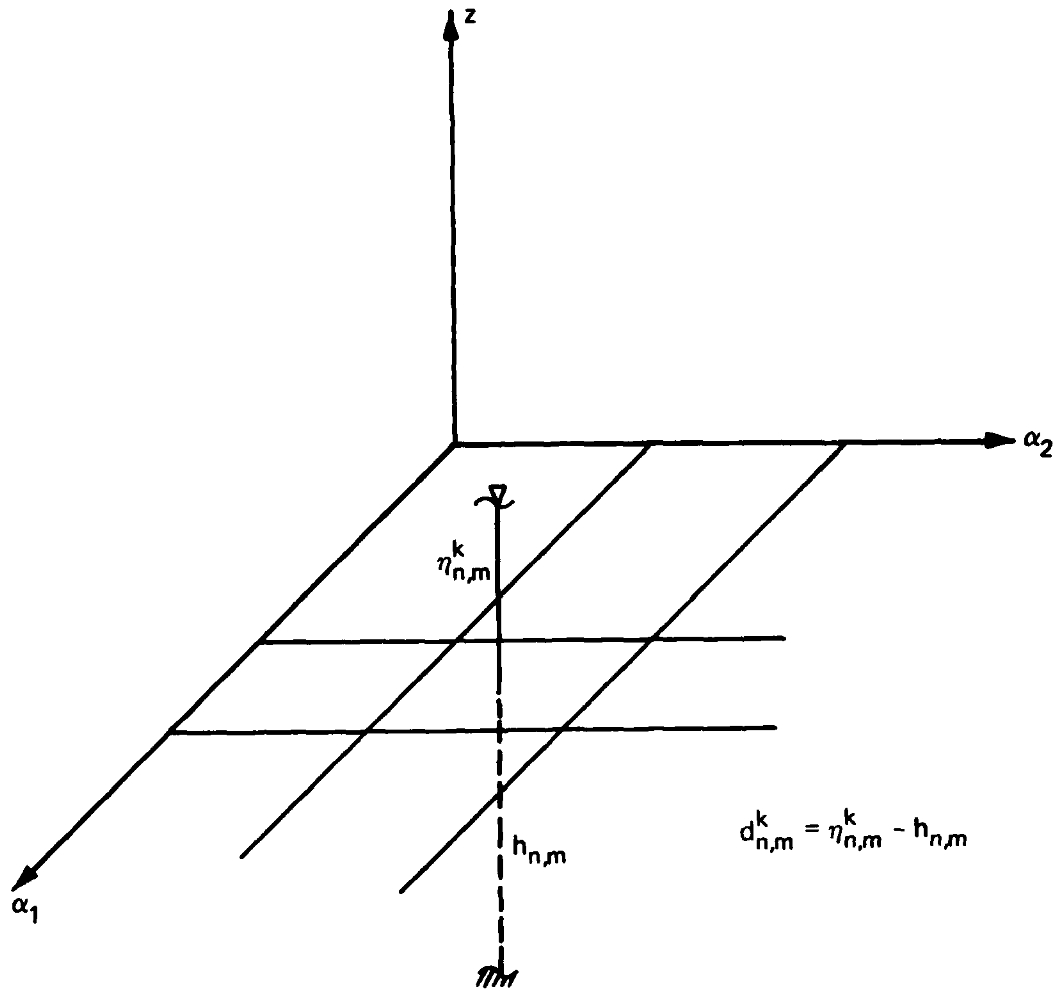

Figure 2. Datum convention employed within the space staggered grid system

Flux-corrected transport scheme

16. Two schemes are used in implementing this approach: a lower order in space nonoscillatory scheme and a higher order in space scheme subject to oscillation. In the method implemented, two time level implicit multioperational ADI schemes were employed. The forward time upwind space (FTUS) and forward time centered space (FTCS) schemes were used as the lower and higher order in space schemes, respectively, and are discussed in turn below. Finally, the necessary flux correction procedures are developed.

17. Leendertse FTCS multioperational scheme. The following finite difference equation is considered as an approximation to the nonlinear transport equation (21):

$$
\begin{aligned}
&\delta'^{\,k}_{t}(ds) + \frac{\Delta t}{2\Delta\alpha_1(\mu_1)_m}\,\delta_{\alpha_1}\left(\overset{\alpha_1}{\overline{d}}{}^{k+1}\,\overset{\alpha_1}{\overline{s}}{}^{k+1}\,u^{k+1} + \overset{\alpha_1}{\overline{d}}{}^{k}\,\overset{\alpha_1}{\overline{s}}{}^{k}\,u^{k}\right) \\
&+ \frac{\Delta t}{2\Delta\alpha_2(\mu_2)_n}\,\delta_{\alpha_2}\left(\overset{\alpha_2}{\overline{d}}{}^{k+1}\,\overset{\alpha_2}{\overline{s}}{}^{k+1}\,v^{k+1} + \overset{\alpha_2}{\overline{d}}{}^{k}\,\overset{\alpha_2}{\overline{s}}{}^{k}\,v^{k}\right) \\
&- \frac{\Delta t}{2(\Delta\alpha_1)^2(\mu_1)_m}\,\delta_{\alpha_1}\left[\overset{\alpha_1}{\overline{d}}{}^{k+1}\,K^{k+1}_{\alpha_1}\,\frac{\delta_{\alpha_1}(s^{k+1})}{(\mu_1)_m} + \overset{\alpha_1}{\overline{d}}{}^{k}\,K^{k}_{\alpha_1}\,\frac{\delta_{\alpha_1}(s^{k})}{(\mu_1)_m}\right] \\
&- \frac{\Delta t}{2(\Delta\alpha_2)^2(\mu_2)_n}\,\delta_{\alpha_2}\left[\overset{\alpha_2}{\overline{d}}{}^{k+1}\,K^{k+1}_{\alpha_2}\,\frac{\delta_{\alpha_2}(s^{k+1})}{(\mu_2)_n} + \overset{\alpha_2}{\overline{d}}{}^{k}\,K^{k}_{\alpha_2}\,\frac{\delta_{\alpha_2}(s^{k})}{(\mu_2)_n}\right] = 0 \quad \text{at } (n,m)
\end{aligned}
\qquad (23)
$$

The solution of the above semi-implicit difference scheme requires the inversion of a large unbanded matrix. In order to reduce computational effort, the following ADI multioperational difference equations are used.

18. The approximations for the X-Sweep may now be written as follows:

$$
\delta_t^k(ds) + \frac{\Delta t\ \delta_{\alpha_1}}{2\Delta\alpha_1(\mu_1)_m}\left(\overline{d^{k+1/2*}}^{\alpha_1}\ \overline{s^{k+1/2*}}^{\alpha_1} u^{k+1/2*}\right)
$$

$$
- \frac{\Delta t\ \delta_{\alpha_1}}{2\Delta\alpha_1^2(\mu_1)_m}\left[\overline{d}^{\alpha_1}{}^{k+1/2*}\ K_{\alpha_1}^{k+1/2*}\ \frac{\delta_{\alpha_1}(s^{k+1/2*})}{(\mu_1)_m}\right] \tag{24}
$$

$$
+ \frac{\Delta t}{2(\mu_2)_n\Delta\alpha_2}\ \delta_{\alpha_2}\left(\overline{d^k}^{\alpha_2}\ \overline{s^k}^{\alpha_2} v^k\right)
$$

$$
- \frac{\Delta t\ \delta_{\alpha_2}}{2\Delta\alpha_2^2(\mu_2)_n}\left[\overline{d}^{\alpha_1}{}^{k}\ K_{\alpha_2}^{k}\ \frac{\delta_{\alpha_2}(s^k)}{(\mu_2)_n}\right] = 0 \quad \text{at } (n,m)
$$

If we place all terms at time level $k+1/2*$ on the left-hand side of the equation and expand $K_x \equiv K_{\alpha_1}$

$$
(ds)_{n,m}^{k+1/2*} + \frac{\Delta t}{2\Delta\alpha_1(\mu_1)_m}\left[\frac{\left(\eta_{n,m+1}^{k+1/2*} - h_{n,m+1} + \eta_{n,m}^{k+1/2*} - h_{n,m}\right)}{2.}\, u_{n,m+1/2}^{k+1/2*}\, \frac{\left(s_{n,m+1}^{k+1/2*} + s_{n,m}^{k+1/2*}\right)}{2.}\right.
$$

$$
\left. - \frac{\left(\eta_{n,m-1}^{k+1/2*} - h_{n,m-1} + \eta_{n,m}^{k+1/2*} - h_{n,m}\right)}{2.}\, u_{n,m-1/2}^{k+1/2*}\, \frac{\left(s_{n,m-1}^{k+1/2*} + s_{n,m}^{k+1/2*}\right)}{2.}\right] \tag{25}
$$

$$
- \frac{\Delta t}{2\Delta\alpha_1^2(\mu_1)_m}\left[\frac{\left(\eta_{n,m+1}^{k+1/2*} - h_{n,m+1} + \eta_{n,m}^{k+1/2*} - h_{n,m}\right)}{2.}\, \frac{\left(s_{n,m+1}^{k+1/2*} - s_{n,m}^{k+1/2*}\right)}{(\mu_1)_{m+1/2}}\, K_{x_{n,m+1/2}}^{k+1/2*}\right.
$$

$$
\left. - \frac{\left(\eta_{n,m-1}^{k+1/2*} - h_{n,m-1} + \eta_{n,m}^{k+1/2*} - h_{n,m}\right)}{2.}\, \frac{\left(s_{n,m}^{k+1/2*} - s_{n,m-1}^{k+1/2*}\right)}{(\mu_1)_{m-1/2}}\, K_{x_{n,m-1/2}}^{k+1/2*}\right]
$$

Collecting all terms in Equation 23 at time level k denoting the result as B_m , we obtain $K_y \equiv K_{\alpha_2}$

$$
\begin{aligned}
B_m = (ds)^k_{n,m} &- \frac{\Delta t}{2\Delta\alpha_2(\mu_2)_n}\left[\frac{\left(\eta^k_{n+1,m} - h_{n+1,m} + \eta^k_{n,m} - h_{n,m}\right)}{2.} V^k_{n+1/2,m}\,\frac{\left(s^k_{n+1,m} + s^k_{n,m}\right)}{2.}\right. \\
&\left. - \frac{\left(\eta^k_{n-1,m} - h_{n-1,m} + \eta^k_{n,m} - h_{n,m}\right)}{2.} V^k_{n-1/2,m}\,\frac{\left(s^k_{n-1,m} + s^k_{n,m}\right)}{2.}\right] \\
&+ \frac{\Delta t}{2(\mu_2)_n(\Delta\alpha_2)^2}\left[\frac{\left(\eta^k_{n+1,m} - h_{n+1,m} + \eta^k_{n,m} - h_{n,m}\right)}{2.}\,\frac{\left(s^k_{n+1,m} - s^k_{n,m}\right)}{(\mu_2)_{n+1/2}}\,K^k_{y_{n+1/2,m}}\right. \\
&\qquad\left. - \frac{\left(\eta^k_{n-1,m} - h_{n-1,m} + \eta^k_{n,m} - h_{n,m}\right)}{2.}\,\frac{\left(s^k_{n,m} - s^k_{n-1,m}\right)}{(\mu_2)_{n-1/2}}\,K^k_{y_{n-1/2,m}}\right]
\end{aligned}
\tag{26}
$$

In Equation 25 we define $-a_{n,m-1}$, $a_{n,m+1}$, and $a_{n,m}$ as follows

$$
-a_{n,m-1} = \frac{\Delta t\left(\frac{\alpha_1}{d}\right)^{k+1/2*}_{n,m-1/2}}{2\Delta\alpha_1(\mu_1)_m}\left[\frac{u^{k+1/2*}_{n,m-1/2}}{2.} + \frac{(K_x)^{k+1/2*}_{n,m-1/2}}{\Delta\alpha_1(\mu_1)_{m-1/2}}\right] \tag{27}
$$

$$
a_{n,m+1} = \frac{\Delta t\left(\frac{\alpha_1}{d}\right)^{k+1/2*}_{n,m+1/2}}{2\Delta\alpha_1(\mu_1)_m}\left[\frac{u^{k+1/2*}_{n,m+1/2}}{2} - \frac{(K_x)^{k+1/2*}_{n,m+1/2}}{\Delta\alpha_1(\mu_1)_{m+1/2}}\right] \tag{28}
$$

$$
\begin{aligned}
a_{n,m} = d^{k+1/2*}_{n,m} &+ \frac{\Delta t}{2\Delta\alpha_1(\mu_1)_m}\left[\frac{\left(\frac{\alpha_1}{du}\right)^{k+1/2*}_{n,m+1/2}}{2} - \frac{\left(\frac{\alpha_1}{du}\right)^{k+1/2*}_{n,m-1/2}}{2}\right] \\
&+ \frac{\Delta t}{2\Delta\alpha_1^2(\mu_1)_m}\left[\frac{\left(\frac{\alpha_1}{dK_x}\right)^{k+1/2*}_{n,m+1/2}}{(\mu_1)_{m+1/2}} + \frac{\left(\frac{\alpha_1}{dK_x}\right)^{k+1/2*}_{n,m-1/2}}{(\mu_1)_{m-1/2}}\right]
\end{aligned}
\tag{29}
$$

19. Collecting all results we obtain the following interior equation for the X-Sweep

$$
a_{n,m-1}\, s^{k+1/2*}_{n,m-1} + a_{n,m}\, s^{k+1/2*}_{n,m} + a_{n,m+1}\, s^{k+1/2*}_{n,m+1} = B_m \tag{30}
$$

20. The approximations for the Y-Sweep may now be written as follows:

$$\delta_t^{k+1/2*}(ds) + \frac{\Delta t\delta_{\alpha_2}}{2\Delta\alpha_2(\mu_2)_n}\left(\frac{\alpha_2}{d^{k+1}}\,\frac{\alpha_2}{s^{k+1}}v^{k+1}\right) - \frac{\Delta t\delta_{\alpha_2}}{2\Delta\alpha_2^2(\mu_2)_n}\left[\frac{\alpha_2}{d}^{k+1}K_{\alpha_2}^{k+1}\,\frac{\delta_{\alpha_2}(s^{k+1})}{(\mu_2)_n}\right]$$

$$+ \frac{\Delta t\delta_{\alpha_1}}{2\Delta\alpha_1(\mu_1)_m}\left(\frac{\alpha_1}{d^{k+1/2*}}\,\frac{\alpha_1}{s^{k+1/2*}}u^{k+1/2*}\right) + \frac{\Delta t\delta_{\alpha_1}}{2\Delta\alpha_1^2(\mu_1)_m}\left[\frac{\alpha_1}{d^{k+1/2*}}K_{\alpha_1}^{k+1/2*}\,\frac{\delta_{\alpha_1}(s^{k+1/2*})}{(\mu_1)_m}\right] = 0 \quad \text{at} \quad (n,m) \qquad (31)$$

Expanding Equation 31 by employing Equation 22 and collecting terms at time level k+1 on the left-hand side and leaving terms at time level k+1/2* on the right-hand side, the following interior equation for the Y-Sweep is obtained:

$$a_{n-1,m}\,s_{n-1,m}^{k+1} + a_{n,m}\,s_{n,m}^{k+1} + a_{n+1,m}\,s_{n+1,m}^{k+1} = B_n \qquad (32)$$

where $\left(K_x \equiv K_{\alpha_1}\ ,\ K_y \equiv K_{\alpha_2}\right)$

$$-a_{n-1,m} = \frac{\Delta t\left(\frac{\alpha_2}{d}\right)_{n-1/2,m}^{k+1}}{2\Delta\alpha_2(\mu_2)_n}\left[\frac{v_{n-1/2,m}^{k+1}}{2} + \frac{(K_y)_{n-1/2,m}^{k+1}}{\Delta\alpha_2(\mu_2)_{n-1/2}}\right] \qquad (33)$$

$$a_{n+1,m} = \frac{\Delta t\left(\frac{\alpha_2}{d}\right)_{n+1/2,m}^{k+1}}{2\Delta\alpha_2(\mu_2)_n}\left[\frac{v_{n+1/2,m}^{k+1}}{2} - \frac{(K_y)_{n+1/2,m}^{k+1}}{\Delta\alpha_2(\mu_2)_{n+1/2}}\right] \qquad (34)$$

$$a_{n,m} = d_{n,m}^{k+1} + \frac{\Delta t}{2\Delta\alpha_2(\mu_2)_n}\left[\frac{\left(\frac{\alpha_2}{dv}\right)_{n+1/2,m}^{k+1}}{2} - \frac{\left(\frac{\alpha_2}{dv}\right)_{n-1/2,m}^{k+1}}{2}\right]$$

$$+ \frac{\Delta t}{2\Delta\alpha_2^2(\mu_2)_n}\left[\frac{\left(\frac{\alpha_2}{dK_y}\right)_{n+1/2,m}^{k+1}}{(\mu_2)_{n+1/2}} + \frac{\left(\frac{\alpha_2}{dK_y}\right)_{n-1/2,m}^{k+1}}{(\mu_2)_{n-1/2}}\right] \qquad (35)$$

$$B_n = (ds)^{k+1/2*}_{n,m} - \frac{\Delta t}{2(\mu_1)_m \Delta\alpha_1}\left[\left(\frac{\alpha_1}{d}\ \frac{\alpha_1}{s}\right)^{k+1/2*}_{n,m+1/2} u^{k+1/2*}_{n,m+1/2} - \left(\frac{\alpha_1}{d}\ \frac{\alpha_1}{s}\right)^{k+1/2*}_{n,m-1/2} u^{k+1/2*}_{n,m-1/2}\right]$$

$$+ \frac{\Delta t}{2(\mu_1)_m(\Delta\alpha_1)^2}\left[\left(\frac{\alpha_1}{dK_x}\right)^{k+1/2*}_{n,m+1/2} \frac{\left(s^{k=1/2*}_{n,m+1} - s^{k+1/2*}_{n,m}\right)}{(\mu_1)_{m+1/2}} - \left(\frac{\alpha_1}{dK_x}\right)^{k+1/2*}_{n,m-1/2} \frac{\left(s^{k+1/2*}_{n,m} - s^{k+1/2*}_{n,m-1}\right)}{(\mu_1)_{m-1/2}}\right] \quad (36)$$

21. Leendertse FTUS multioperational scheme. The following finite difference equation is considered as an approximation to the nonlinear transport equation (21):

$$\delta'^{k}_{t}(ds) + \frac{\Delta t}{2\Delta\alpha_1(\mu_1)_m}\delta_{\alpha_1}\left(\frac{\alpha_1}{d}^{k+1}\frac{u}{s_1}^{k+1} u^{k+1} + \frac{\alpha_1}{d}^{k}\frac{u}{s_1}^{k} u^{k}\right)$$

$$+ \frac{\Delta t}{2\Delta\alpha_2(\mu_2)_n}\delta_{\alpha_2}\left(\frac{\alpha_2}{d}^{k+1}\frac{v}{s_2}^{k+1} v^{k+1} + \frac{\alpha_2}{d}^{k}\frac{v}{s_2}^{k} v^{k}\right)$$

$$- \frac{\Delta t}{2(\Delta\alpha_1)^2(\mu_1)_m}\delta_{\alpha_1}\left[\frac{\alpha_1}{d}^{k+1} K^{k+1}_{\alpha_1}\frac{\delta_{\alpha_1}(s^{k+1})}{(\mu_1)_m} + \frac{\alpha_1}{d}^{k} K^{k}_{\alpha_1}\frac{\delta_{\alpha_1}(s^{k})}{(\mu_1)_m}\right] \quad (37)$$

$$- \frac{\Delta t}{2(\Delta\alpha_2)^2(\mu_2)_n}\delta_{\alpha_2}\left[\frac{\alpha_2}{d}^{k+1} K^{k+1}_{\alpha_2}\frac{\delta_{\alpha_2}(s^{k+1})}{(\mu_2)_n} + \frac{\alpha_2}{d}^{k} K^{k}_{\alpha_2}\frac{\delta_{\alpha_2}(s^{k})}{(\mu_2)_n}\right] = 0 \quad \text{at } (n,m)$$

22. The following upwind difference operators are used in the above equation and are defined at (n,m) as follows:

$$\frac{f}{s_1}^{k} = \begin{cases} s^{k}_{n,m-1/2} & f^{k}_{n,m} \geq 0 \\ s^{k}_{n,m+1/2} & f^{k}_{n,m} < 0 \end{cases}$$

$$\frac{f}{s_2}^{k} = \begin{cases} s^{k}_{n-1/2,m} & f^{k}_{n,m} \geq 0 \\ s^{k}_{n+1/2,m} & f^{k}_{n,m} < 0 \end{cases} \quad (38)$$

23. To effect the solution of this scheme, the inversion of an unbanded matrix is again required. Thus, an ADI scheme similar to the previous technique (upwind differencing is employed for the advective terms) is used. The necessary modifications for the X-Sweep are shown in Table 1 while those employed for the Y-Sweep are given in Table 2.

24. Flux correction procedures. If the factorization terms are ignored, the schemes above may be written in the following flux format:

$$d^{k+1}_{n,m} s^{I}_{n,m} = d^{k}_{n,m} s^{k}_{n,m} - \left[\Delta\alpha_1 (\mu_1)_m \Delta\alpha_2 (\mu_2)_n\right]^{-1} \left(F^{I}_{n+1/2,m} - F^{I}_{n-1/2,m} + F^{I}_{n,m+1/2} - F^{I}_{n,m-1/2}\right) \tag{39}$$

where $t = k\Delta t$, $x = \sum_i (\mu_1)_i \Delta\alpha_1$, $y = \sum_i (\mu_2)_i \Delta\alpha_2$

$S^{k}_{n,m}$ ≡ concentration at location (n,m) at time level k

$\Delta\alpha_1(\mu_1)_m$ ≡ x space step at m

$\Delta\alpha_2(\mu_2)_n$ ≡ y space step at n

I ≡ general index at time level $k+1$, which we set to H or L for the higher or lower scheme, respectively

$F^{I}_{n\pm1/2,m\pm1/2}$ ≡ fluxes through the appropriate cell faces of cell (n,m). Form is dependent upon the finite difference formulation

We observe from Equation 39 that the difference between the higher and lower order scheme at (n,m) may be written as follows:

$$\left(S^{H}_{n,m} - S^{L}_{n,m}\right) = -\left[\Delta\alpha_1(\mu_1)_m \Delta\alpha_2(\mu_2)_n d^{k+1}_{n,m}\right]^{-1} \left[\left(F^{H}_{n+1/2,m} - F^{L}_{n+1/2,m}\right) - \left(F^{H}_{n-1/2,m} - F^{L}_{n-1/2,m}\right) + \left(F^{H}_{n,m+1/2} - F^{L}_{n,m+1/2}\right) - \left(F^{H}_{n,m-1/2} - F^{L}_{n,m-1/2}\right)\right] \tag{40}$$

Note this difference may be expressed as an array of fluxes between adjacent grid points and is the condition required to effect the flux correction procedures as given by Zalesak (1979). We next develop the flux expressions for the higher (F^H) and lower (F^L) order schemes. In order to aid in notation, we make the following definition for an arbitrary variable, F :

Table 1

<u>X-Sweep Modifications FTUS</u>

Equation	FTCS	FTUS	
26	$\frac{\left(s^k_{n+1,m} + s^k_{n,m}\right)}{2}$	$s^k_{n,m}$	$v^k_{n+1/2,m} \geq 0$
		$s^k_{n+1,m}$	$v^k_{n+1/2,m} < 0$
26	$\frac{\left(s^k_{n-1,m} + s^k_{n,m}\right)}{2}$	$s^k_{n-1,m}$	$v^k_{n-1/2,m} \geq 0$
		$s^k_{n,m}$	$v^k_{n-1/2,m} < 0$
27	$\frac{u^{k+1/2*}_{n,m-1/2}}{2}$	$\max\left(0\ ,\ u^{k+1/2*}_{n,m-1/2}\right)$	
28	$\frac{u^{k+1/2*}_{n,m+1/2}}{2}$	$\min\left(0\ ,\ u^{k+1/2*}_{n,m+1/2}\right)$	
29	$\frac{\left(\frac{\alpha_1}{du}\right)^{k+1/2*}_{n,m+1/2}}{2}$	$\max\left[0\ ,\ \left(\frac{\alpha_1}{du}\right)^{k+1/2*}_{n,m+1/2}\right]$	
29	$\frac{\left(\frac{\alpha_1}{du}\right)^{k+1/2*}_{n,m-1/2}}{2}$	$\min\left[0\ ,\ \left(\frac{\alpha_1}{du}\right)^{k+1/2*}_{n,m-1/2}\right]$	

Table 2

Y-Sweep Modifications FTUS

Equation	FTCS	FTUS
33	$\frac{v^{k+1}_{n-1/2,m}}{2}$	$\max\left(0\ ,\ v^{k+1}_{n-1/2,m}\right)$
34	$\frac{v^{k+1}_{n+1/2,m}}{2}$	$\min\left(0\ ,\ v^{k+1}_{n+1/2,m}\right)$
35	$\frac{\left(\frac{\alpha_2}{dv}\right)^{k+1}_{n+1/2,m}}{2}$	$\max\left[0\ ,\ \left(\frac{\alpha_2}{dv}\right)^{k+1}_{n+1/2,m}\right]$
35	$\frac{\left(\frac{\alpha_2}{dv}\right)^{k+1}_{n-1/2,m}}{2}$	$\min\left[0\ ,\ \left(\frac{\alpha_2}{dv}\right)^{k+1}_{n-1/2,m}\right]$
36	$\left(\frac{\alpha_1}{d}\ \frac{\alpha_1}{s}\right)^{k+1/2*}_{n,m+1/2}$	$\frac{\alpha_1}{d}{}^{k+1/2*}_{n,m+1/2}\ s^{k+1/2*}_{n,m} \qquad u^{k+1/2*}_{n,m+1/2} \geq 0$
		$\frac{\alpha_1}{d}{}^{k+1/2*}_{n,m+1/2}\ s^{k+1/2*}_{n,m+1} \qquad u^{k+1/2*}_{n,m+1/2} < 0$
36	$\left(\frac{\alpha_1}{d}\ \frac{\alpha_1}{s}\right)^{k+1/2*}_{n,m-1/2}$	$\frac{\alpha_1}{d}{}^{k+1/2*}_{n,m-1/2}\ s^{k+1/2*}_{n,m-1} \qquad u^{k+1/2*}_{n,m-1/2} \geq 0$
		$\frac{\alpha_1}{d}{}^{k+1/2*}_{n,m-1/2}\ s^{k+1/2*}_{n,m} \qquad u^{k+1/2*}_{n,m-1/2} < 0$

$$F^{k+1/2}_{n,m} = \left(F^{k+1}_{n,m} + F^{k}_{n,m}\right) \Big/ 2 \tag{41}$$

25. For the higher order scheme we employ the FTCS scheme written in Equation 23 in which the factorization terms developed in the multioperational method are not shown. Equation 23 may be written in the form of Equation 39, where the total fluxes are presented as the sum of advective and diffusive fluxes.

26. From Equation 23 one then obtains for the advective fluxes:

$$F^{H_A}_{n\pm1/2,m} = v^{k+1/2}_{n\pm1/2,m}\Delta t(\mu_1)_m\Delta\alpha_1\left[\left(\frac{S^H + S^k}{2}\right)_{n\pm1,m} d^{k+1/2}_{n\pm1,m} + \left(\frac{S^H + S^k}{2}\right)_{n,m} d^{k+1/2}_{n,m}\right] \Big/ 2 \tag{42}$$

$$F^{H_A}_{n,m\pm1/2} = u^{k+1/2}_{n,m\pm1/2}\Delta t(\mu_2)_n\Delta\alpha_2\left[\left(\frac{S^H + S^k}{2}\right)_{n,m\pm1} d^{k+1/2}_{n,m\pm1} + \left(\frac{S^H + S^k}{2}\right)_{n,m} d^{k+1/2}_{n,m}\right] \Big/ 2 \tag{43}$$

The diffusive fluxes are then given by the following relations $(K_x \equiv K_{\alpha_1}\ ,\ K_y \equiv K_{\alpha_1})$:

$$F^{H_O}_{n\pm1/2,m} = \pm K_{y\,n\pm1/2,m}^{\;k+1/2}\ \frac{\Delta t(\mu_1)_m\Delta\alpha_1}{2} \times \frac{\left[(S^H + S^k)_{n,m} - (S^H + S^k)_{n\pm1,m}\right]}{\Delta\alpha_2(\mu_2)_{n\pm1/2}}\ \frac{\left(d^{k+1/2}_{n\pm1,m} + d^{k+1/2}_{n,m}\right)}{2} \tag{44}$$

$$F^{H_O}_{n,m\pm1/2} = \pm K_{x_{n,m\pm1/2}}^{k+1/2} \frac{\Delta t(\mu_2)_n \Delta\alpha_2}{2}$$

$$\times \frac{\left[(S^H + S^k)_{n,m} - (S^H + S^k)_{n,m\pm1}\right]}{\Delta\alpha_1(\mu_1)_{m\pm1/2}} \frac{\left(d^{k+1/2}_{n,m\pm1} + d^{k+1/2}_{n,m}\right)}{2} \tag{45}$$

27. For the lower order scheme, the FTUS scheme written in Equation 37 is employed. Factorization terms generated by the multioperational method are not considered. Equation 37 is written in the form of Equation 39. The total fluxes are presented as the sum of advective and diffusive fluxes.

28. From Equation 37 one obtains the following set of advective fluxes:

$$F^{L_A}_{n+1/2,m} = \begin{cases} v^{k+1/2}_{n+1/2,m} \geq 0 & v^{k+1/2}_{n+1/2,m}\Delta t(\mu_1)_m \Delta\alpha_1\left(\frac{S^L + S^k}{2}\right)_{n,m} d^{k+1/2}_{n,m} \\ v^{k+1/2}_{n+1/2,m} < 0 & v^{k+1/2}_{n+1/2,m}\Delta t(\mu_1)_m \Delta\alpha_1\left(\frac{S^L + S^k}{2}\right)_{n+1,m} d^{k+1/2}_{n+1,m} \end{cases} \tag{46}$$

$$F^{L_A}_{n-1/2,m} = \begin{cases} v^{k+1/2}_{n-1/2,m} \geq 0 & v^{k+1/2}_{n-1/2,m}\Delta t(\mu_1)_m \Delta\alpha_1\left(\frac{S^L + S^k}{2}\right)_{n-1,m} d^{k+1/2}_{n-1,m} \\ v^{k+1/2}_{n-1/2,m} < 0 & v^{k+1/2}_{n-1/2,m}\Delta t(\mu_1)_m \Delta\alpha_1\left(\frac{S^L + S^k}{2}\right)_{n,m} d^{k+1/2}_{n,m} \end{cases} \tag{47}$$

$$F^{L_A}_{n,m+1/2} = \begin{cases} u^{k+1/2}_{n,m+1/2} \geq 0 & u^{k+1/2}_{n,m+1/2}\Delta t(\mu_2)_n \Delta\alpha_2\left(\frac{S^L + S^k}{2}\right)_{n,m} d^{k+1/2}_{n,m} \\ u^{k+1/2}_{n,m+1/2} < 0 & u^{k+1/2}_{n,m+1/2}\Delta t(\mu_2)_n \Delta\alpha_2\left(\frac{S^L + S^k}{2}\right)_{n,m+1} d^{k+1/2}_{n,m+1} \end{cases} \tag{48}$$

$$F^{L_A}_{n,m-1/2} = \begin{cases} u^{k+1/2}_{n,m-1/2} \geq 0 & u^{k+1/2}_{n,m-1/2}\Delta t(\mu_2)_n \Delta\alpha_2\left(\frac{S^L + S^k}{2}\right)_{n,m-1} d^{k+1/2}_{n,m-1} \\ u^{k+1/2}_{n,m-1/2} < 0 & u^{k+1/2}_{n,m-1/2}\Delta t(\mu_2)_n \Delta\alpha_2\left(\frac{S^L + S^k}{2}\right)_{n,m} d^{k+1/2}_{n,m} \end{cases} \tag{49}$$

The diffusive fluxes are obtained from Equations 44 and 45 with H replaced by L .

29. The antidiffusive fluxes are then computed as follows:

$$A_{n\pm1/2,m} = F^{H_A}_{n\pm1/2,m} - F^{L_A}_{n\pm1/2,m} + F^{H_O}_{n\pm1/2,m} - F^{L_O}_{n\pm1/2,m} \tag{50}$$

$$A_{n,m\pm1/2} = F^{H_A}_{n,m\pm1/2} - F^{L_A}_{n,m\pm1/2} + F^{H_O}_{n,m\pm1/2} - F^{L_O}_{n,m\pm1/2} \tag{51}$$

In computing the difference between the diffusive fluxes (third and fourth terms in the above expressions), note that the terms with $S^k_{n,m}$ may be completely eliminated.

30. Next the maximum and minimum cell values are determined:

$$S^a_{n,m} = \max\left(S^k_{n,m}, S^L_{n,m}\right) \qquad S^b_{n,m} = \min\left(S^k_{n,m}, S^L_{n,m}\right) \tag{52}$$

$$S^{max}_{n,m} = \max\left(S^a_{n-1,m}, S^a_{n,m}, S^a_{n+1,m}, S^a_{n,m-1}, S^a_{n,m+1}\right) \tag{53}$$

$$S^{min}_{n,m} = \min\left(S^b_{n-1,m}, S^b_{n,m}, S^b_{n+1,m}, S^b_{n,m-1}, S^b_{n,m+1}\right) \tag{54}$$

31. Next the sum of all antidiffusive fluxes into cell (n,m), $P^+_{n,m}$, is determined:

$$P^+_{n,m} = \max(0, A_{n-1/2,m}) - \min(0, A_{n+1/2,m})$$

$$+ \max(0, A_{n,m-1/2}) - \min(0, A_{n,m+1/2}) \tag{55}$$

The maximum allowable mass into the cell, $Q^+_{n,m}$, is then computed as follows:

$$Q^+_{n,m} = \left(S^{max}_{n,m} - S^L_{n,m}\right)\left[(\mu_1)_m \Delta\alpha_1 (\mu_2)_n \Delta\alpha_2 d^{k+1}_{n,m}\right] \tag{56}$$

32. Similarly, the sum of all antidiffusive fluxes out of cell (n,m), $P^-_{n,m}$, is determined:

$$P^-_{n,m} = \max(0, A_{n+1/2,m}) - \min(0, A_{n-1/2,m}) + \max(0, A_{n,m+1/2}) - \min(0, A_{n,m-1/2}) \quad (57)$$

The maximum allowable mass to leave the cell, $Q^-_{n,m}$, is then computed:

$$Q^-_{n,m} = \left(S^L_{n,m} - S^{min}_{n,m}\right)\left[(\mu_1)_m \Delta\alpha_1 (\mu_2)_n \Delta\alpha_2 d^{k+1}_{n,m}\right] \quad (58)$$

33. The following ratios are next computed for use in determining the limiting coefficients:

$$R^+_{n,m} = \begin{Bmatrix} \min\left(1, Q^+_{n,m} \middle/ P^+_{n,m}\right) & P^+_{n,m} > 0 \\ 0 & P^+_{n,m} = 0 \end{Bmatrix} \quad (59)$$

$$R^-_{n,m} = \begin{Bmatrix} \min\left(1, Q^-_{n,m} \middle/ P^-_{n,m}\right) & P^-_{n,m} > 0 \\ 0 & P^-_{n,m} = 0 \end{Bmatrix} \quad (60)$$

The limiting coefficients are then given by

$$C_{n+1/2,m} = \begin{Bmatrix} \min\left(R^+_{n+1,m}, R^-_{n,m}\right) & A_{n+1/2,m} \geq 0 \\ \min\left(R^+_{n,m}, R^-_{n+1,m}\right) & A_{n+1/2,m} < 0 \end{Bmatrix}$$

$$C_{n,m+1/2} = \begin{Bmatrix} \min\left(R^+_{n,m+1}, R^-_{n,m}\right) & A_{n,m+1/2} \geq 0 \\ \min\left(R^+_{n,m}, R^-_{n,m+1}\right) & A_{n,m+1/2} < 0 \end{Bmatrix} \quad (61)$$

34. The antidiffusive fluxes in Equations 50 and 51 are limited by multiplying by the limiting coefficients and the solution is advanced to the next time level:

$$
\begin{aligned}
S^{k+1}_{n,m} = S^{L}_{n,m} - \left[\Delta\alpha_1 (\mu_1)_m \Delta\alpha_2 (\mu_2)_n d^{k+1}_{n,m}\right]^{-1} & C_{n+1/2,m}A_{n+1/2,m} \\
& - C_{n-1/2,m}A_{n-1/2,m} + C_{n,m+1/2}A_{n,m+1/2} - C_{n,m-1/2}A_{n,m-1/2}
\end{aligned}
\tag{62}
$$

We observe that for $C_{n+1/2,m} = C_{n,m\pm 1/2} = 0$, $S^{k+1}_{n,m} = S^{L}_{n,m}$ and for $C_{n\pm 1/2,m} = C_{n,m\pm 1/2} = 1.0$, $S^{k+1}_{n,m} = S^{H}_{n,m}$.

35. The coding of the flux corrected transport procedures is presented in Subroutine CONC in Appendix A.

Three time level explicit scheme

36. In order to avoid the averaging of hydrodynamic quantities, which is performed when employing a two time level transport scheme with a three time level velocity scheme, a three time level explicit scheme is considered.

37. It is instructive to observe the form of the continuity equation employed in the multioperational hydrodynamic scheme.

X-Sweep:

$$
\begin{aligned}
\frac{1}{2\Delta t}\left(\eta^{*} - \eta^{k-1}\right)_{n,m} + \frac{1}{2\left(\mu_1\right)_m \Delta\alpha_1}\left[\left(u^{k+1} + u^{k-1}\right) \overset{\alpha_1}{\overline{d}}{}^{k}\Big|_{n,m+1/2} - \left(u^{k+1} + u^{k-1}\right) \overset{\alpha_1}{\overline{d}}{}^{k}\Big|_{n,m-1/2}\right] & \\
+ \frac{1}{\left(\mu_2\right)_n \Delta\alpha_2}\left[v^{k-1} \overset{\alpha_2}{\overline{d}}{}^{k}\Big|_{n+1/2,m} - v^{k-1} \overset{\alpha_2}{\overline{d}}{}^{k}\Big|_{n-1/2,m}\right] = 0 \quad \text{at } (n,m) &
\end{aligned}
\tag{63}
$$

with

$$
\overset{\alpha_1}{\overline{d}}_{n,m\pm 1/2} = d^{k}_{n,m\pm 1} + d^{k}_{n,m}
$$

$$
\overset{\alpha_2}{\overline{d}}_{n\pm 1/2,m} = d^{k}_{n\pm 1,m} + d^{k}_{n,m}
$$

and

$$d^k_{n,m} = \eta^k_{n,m} - h_{n,m}$$

Y-Sweep:

$$\frac{1}{2\Delta t}\left(\eta^{k+1}_{n,m} - \eta^{*}_{n,m}\right) + \frac{1}{2\left(\mu_2\right)_n \Delta\alpha_2}\left[\left(v^{k+1} - v^{k-1}\right)\frac{\alpha_2}{d}k\Bigg|_{n+1/2,m} - \left(v^{k+1} - v^{k-1}\right)\frac{\alpha_2}{d}k\Bigg|_{n-1/2,m}\right] = 0 \tag{64}$$

at (n,m)

where

$\Delta t \equiv$ time step length

$\eta^* \equiv$ water surface elevation at intermediate time level $*$

$\eta^{k\pm1}_{n,m} \equiv$ water surface elevation at time level $k\pm1$ at cell (n,m)

$\Delta\alpha_1 \equiv \alpha_1$ space increment

$\Delta\alpha_2 \equiv \alpha_2$ space increment

$u^{k+1}_{n,m+1/2} \equiv x - \alpha_1$ velocity component at time level $k+1$ at cell (n,m)

$u^{k-1}_{n,m+1/2} \equiv x - \alpha_1$ velocity component at time level $k-1$ at cell (n,m)

$v^{k+1}_{n+1/2,m} \equiv y - \alpha_2$ velocity component at time level $k+1$ at cell (n,m)

$v^{k-1}_{n+1/2,m} \equiv y - \alpha_2$ velocity component at time level $k-1$ at cell (n,m)

$d^k_{n,m} \equiv$ water depth at time level k at cell (n,m)

If we eliminate the intermediate level η^* ; e.g., solve for η^* in Equation 63 and substitute in Equation 64, we obtain:

$$\frac{\left(\eta^{k+1}_{n,m} - \eta^{k-1}_{n,m}\right)}{2\Delta t} + \frac{1}{2\left(\mu_1\right)_m \Delta\alpha_1}\left[\left(u^{k+1} + u^{k-1}\right)\frac{\alpha_1}{d}k\Bigg|_{n,m+1/2} - \left(u^{k+1} + u^{k-1}\right)\frac{\alpha_1}{d}k\Bigg|_{n,m-1/2}\right]$$

$$+ \frac{1}{2\left(\mu_2\right)_n \Delta\alpha_2}\left[\left(v^{k+1} + v^{k-1}\right)\frac{\alpha_2}{d}k\Bigg|_{n+1/2,m} - \left(v^{k+1} + v^{k-1}\right)\frac{\alpha_2}{d}k\Bigg|_{n-1/2,m}\right] = 0 \tag{65}$$

at (n,m)

Since $d^k_{n,m} = \eta^k_{n,m} - h_{n,m}$, Equation 65 is a full three time level scheme. In order to develop a three time level volume consistent transport scheme, we <u>associate</u> in the advective terms $d^k_{n,m} S^k_{n,m} \equiv d^k_{n,m}$; e.g.,

$$
\frac{\left(d^{k+1}_{n,m}s^{k+1}_{n,m} - d^{k-1}_{n,m}s^{k-1}_{n,m}\right)}{2\Delta t} + \frac{1}{2\left(\mu_1\right)_m \Delta\alpha_1}\left[\left(u^{k+1} + u^{k-1}\right) \overset{\alpha_1}{\overline{d}}{}^{k}\, \overset{\alpha_1}{\overline{s}}{}^{k}\Big|_{n,m+1/2} - \left(u^{k+1} + u^{k-1}\right) \overset{\alpha_1}{\overline{d}}{}^{k}\, \overset{\alpha_1}{\overline{s}}{}^{k}\Big|_{n,m-1/2}\right]
$$

$$
+ \frac{1}{2\left(\mu_2\right)_n \Delta\alpha_2}\left[\left(v^{k+1} + v^{k-1}\right) \overset{\alpha_2}{\overline{d}}{}^{k}\, \overset{\alpha_2}{\overline{s}}{}^{k}\Big|_{n+1/2,m} - \left(v^{k+1} + v^{k-1}\right) \overset{\alpha_2}{\overline{d}}{}^{k}\, \overset{\alpha_2}{\overline{s}}{}^{k}\Big|_{n-1/2,m}\right]
$$

$$
= + \frac{1}{\left(\mu_1\right)_m \left(\Delta\alpha_1\right)^2}\left[\overset{\alpha_1}{\overline{d}}{}^{k-1} K^{k-1}_{\alpha_1}\Big|_{n,m+1/2} \frac{\left(s^{k-1}_{n,m+1} - s^{k-1}_{n,m}\right)}{\left(\mu_1\right)_{m+1/2}} - \overset{\alpha_1}{\overline{d}}{}^{k-1} K^{k-1}_{\alpha_1}\Big|_{n,m-1/2} \frac{\left(s^{k-1}_{n,m} - s^{k-1}_{n,m-1}\right)}{\left(\mu_1\right)_{m-1/2}}\right] \tag{66}
$$

$$
+ \frac{1}{\left(\mu_2\right)_n \left(\Delta\alpha_2\right)^2}\left[\overset{\alpha_2}{\overline{d}}{}^{k-1} K^{k-1}_{\alpha_2}\Big|_{n+1/2,m} \frac{\left(s^{k-1}_{n+1,m} - s^{k-1}_{n,m}\right)}{\left(\mu_2\right)_{n+1/2}} - \overset{\alpha_2}{\overline{d}}{}^{k-1} K^{k-1}_{\alpha_2}\Big|_{n-1/2,m} \frac{\left(s^{k-1}_{n,m} - s^{k-1}_{n-1,m}\right)}{\left(\mu_2\right)_{n-1/2}}\right]
$$

38. The stability properties of the above scheme were investigated for the range of conditions to be simulated in Mississippi Sound. The scheme was stable over this range of flow conditions. Details may be found in Schmalz (1984). The coding of the three time level scheme is presented in Subroutine CONCE in Appendix A.

<u>Dispersion coefficient formulation</u>

39. To close the numerical approximations to the two-dimensional, depth-averaged transport equation, relations for the effective dispersion coefficients may be developed in terms of flow field properties.

40. The effective disperison coefficients are assumed to have the following form:

$$
K^*_x = C_x\sqrt{g}\,\frac{|u|h}{C} + D_x \; ; \quad K^*_y = C_y\sqrt{g}\,\frac{|v|h}{C} + D_y \tag{67}
$$

where

K^*_x, K^*_y ≡ effective dispersion coefficients in the x- and y-directions, respecitvely

g ≡ acceleration due to gravity

u,v ≡ velocity components in the x- and y-directions, respectively

h ≡ water depth

C ≡ Chezy coefficient

C_x, C_y ≡ dispersion factors in the x- and y-directions, respectively

D_x, D_y ≡ dispersion offsets due to wind effects in the x- and y-directions, respectively ($D_x, D_y > 0$)

For a unidirectional flow in an infinitely wide channel in the x-direction, Elder (1959) found $C_x = 5.93$ and $C_y = 0.23$. Harleman et al. (1959) has converted Taylor's result (1954) for pipe flow and determined $C_x = 14.3\sqrt{2}$. In attempting to apply these results to a two-dimensional flow problem the following approach is employed. Initially, C_x, C_y, D_x, and D_y are specified by the user as model input. The cell face conditions for each cell are examined independently in each coordinate direction. For a no-flux cell face condition, C_x or C_y and D_x or D_y are set to zero. For a standard flow condition, the advective flag system is examined to determine if the flow is restricted in the x- or y-direction. If the flow is restricted, C_x or C_y is reduced by a user-specified factor.

PART III: MODEL INPUT REQUIREMENTS

41. The constituent transport schemes are included with the hydrodynamics as separate subroutines in WIFM-SAL. Therefore, the model user must also be concerned with both the hydrodynamic input requirements as well as those of the transport computations. The complete input requirements for WIFM-SAL are presented in Appendix B and consist of 29 separate card groups. Constituent transport input requirements consist of the following categories:

- a. Constituent Simulation Control.
- b. Boundary Condition Control.
- c. Boundary Condition Data.
- d. Wind Data.
- e. Constituent Initial Condition Data.
- f. Dispersion Coefficient Data.
- g. Output Control.

Each category will be discussed in detail below with reference to the appropriate card groups contained in Appendix B.

Constituent Simulation Control

42. This data group is contained in Card Group 2a. The model user sets ISAL = 1 to consider constituent transport in conjunction with the hydrodynamics. The desired transport scheme is selected by specifying ISALS. For ISALS = 1 , the FCT scheme is employed, while for ISALS = 2 , the full three time level explicit scheme is used. Constituent transport computations are initiated ISALC time steps after the start of the hydrodynamic computations. The user may set ISALC $\neq$ 0 in order to allow for the hydrodynamic computations to be free from initial condition effects before considering constituent transport. CMAX and XMS are self-explanatory.

Boundary Condition Control

43. This data group is contained in Card Groups 3a and 3b. In Card Group 3a the user specifies the number of tidal elevation signals specified by tidal constituents. For a simulation over a global grid, NGLOB = 0 , and NTI is specified as the number of tidal boundary (water surface elevation and

constituent level) signals along the seaward boundary used for interpolation. For a simulation over a refined grid, NTI = 0 , and NGLOB is specified as the number of previously saved tidal signals (water surface elevations and constituent levels) generated from a global grid simulation to be used for cell-centered interpolation along the boundary of the refined grid.

44. In Card Group 3b, the user specifies the grid indices for the grid employed in the current simulation where the known tidal signals are available.

Boundary Condition Data

45. Boundary condition format is specified in Card Group 3. The user specifies ITID as the number of entries in the tidal (elevation and constituents level) input and/or flow (discharge and constituent level) input data tables. The number of time steps between entries in these tables is common and is specified as JTID.

46. In Card Groups 20c and 21b, the constituent levels associated with tidal and flow inputs are specified, respectively.

Wind Data

47. Detailed requirements will not be discussed here. Let it suffice to say that wind conditions may want to be considered when simulating constituent transport. The pertinent input variables requiring specification are as follows:

a. WA, THETA in Card Group 4.

b. NTABLE in Card Group 5.

c. WAT_i, $THAT_i$ in Card Group 6 (optional depending on wind format).

Constituent Initial Condition Data

48. In Card Group 13a, the user specifies a single format or combination of formats to be used for specifying the constituent initial condition. IDEPTH specifies the number of depth intervals used to interpolate based upon depth. If IDEPTH $\neq 0$, a set of initial constituent levels TMP_N are associated with depth values $D_{N,1}$ as specified in Card Group 13b. IFIELD

specifies the number of patches in which initial levels will be specified on a cell-by-cell basis. If IFIELD $\neq 0$, the limits of patch and the individual cell constituent levels are specified in turn for each patch in Card Group 13c. IZONE specifies that a number of zones in which the initial constituent level will be a constant will be assumed. If IZONE $\neq 0$, the number of zones, the limits of the zone, and the constant value of initial constituent level for the zone are specified in Card Group 13d.

49. There is considerable flexibility in specifying initial constituent levels. Each format may be used individually or to override the previous format. For example, the user may specify the initial conditions using depth interpolation. In selected areas of the grid where detailed information is available, the patch concept can be used to override the depth interpolation. In still different areas of the grid, the zone concept can be used to specify a uniform level.

Dispersion Coefficient Data

50. Dispersion factors and offsets due to wind effects are specified in turn for each coordinate direction in a zone format as shown in Card Group 13e.

51. The reduction factor applied to the dispersion factors in cases of flow restriction is specified in Card Group 17b.

Output Control

52. Snapshots of the entire constituent field are printed after completion of up to 32 user-specified time steps during the simulation. Time step completion data are read in Card Group 7 in the NPRINT array.

53. Alternatively, the user may examine constituent level histories at NGAGE locations at NFREQ time step intervals as specified in Card Group 5. The NGAGE locations are specified in terms of the grid indicies in Card Group 8.

PART IV: APPLICATION TO MISSISSIPPI SOUND

54. Both the FCT and the three time level schemes have been applied to the study of salinity distributions in Mississippi Sound by Schmalz (1984). The schemes were exercised on a global grid and also over a local refined grid. Wind sensitivity results for both grid applications are presented in turn below.

Global Grid Results

55. The horizontal salinity distribution was simulated within Mississippi Sound and adjacent areas employing an exponentially stretched global grid as shown in Figure 3. This grid employs 115 × 59 = 6785 cells. Maximum spatial resolution (approximately 3500 ft*) is obtained in the passes into Mississippi Sound. Depths within Mississippi Sound are relatively shallow (10-20 ft), except in the navigation channels, which are normally maintained at 30 to 35 ft. As a result, the gravity wave speed within the Sound is less than 38 fps, resulting in an explicit time step limit of approximately 100 sec. All simulation employed a 360-sec (6 min) time step, resulting in a maximum spatial Courant number of less than 4 within the Sound.

56. Hydrodynamics and salinity conditions over the period 20-24 Sep 1980 were simulated. Water surface elevations along the seaward boundary were obtained from a Gulf Tide Model developed by Reid and Whitaker (1981). Salinity transect data were available on 20 and 21 September. These values were located on the global grid and two rectangular areas were set up in which salinity values were visually interpolated from the located transect values. National Marine Fisheries data were obtained for cruises No. 106 (Apr 1980) and No. 112 (Nov 1980) of the OREGON II. These data provided a general understanding of salinity patterns in the vicinity of the Mississippi Delta. A deep sea vertically averaged value of 36 ppt was employed.

57. Initial conditions were assigned in a three step process as shown in Table 3. In step one, values were assigned based on cell water depth. In step two, salinity values were specified within Mississippi Sound based on salinity transect data. In step three, initial salinity values within

---

* A table of factors for converting U. S. customary units of measurement to metric (SI) is presented on page 3.

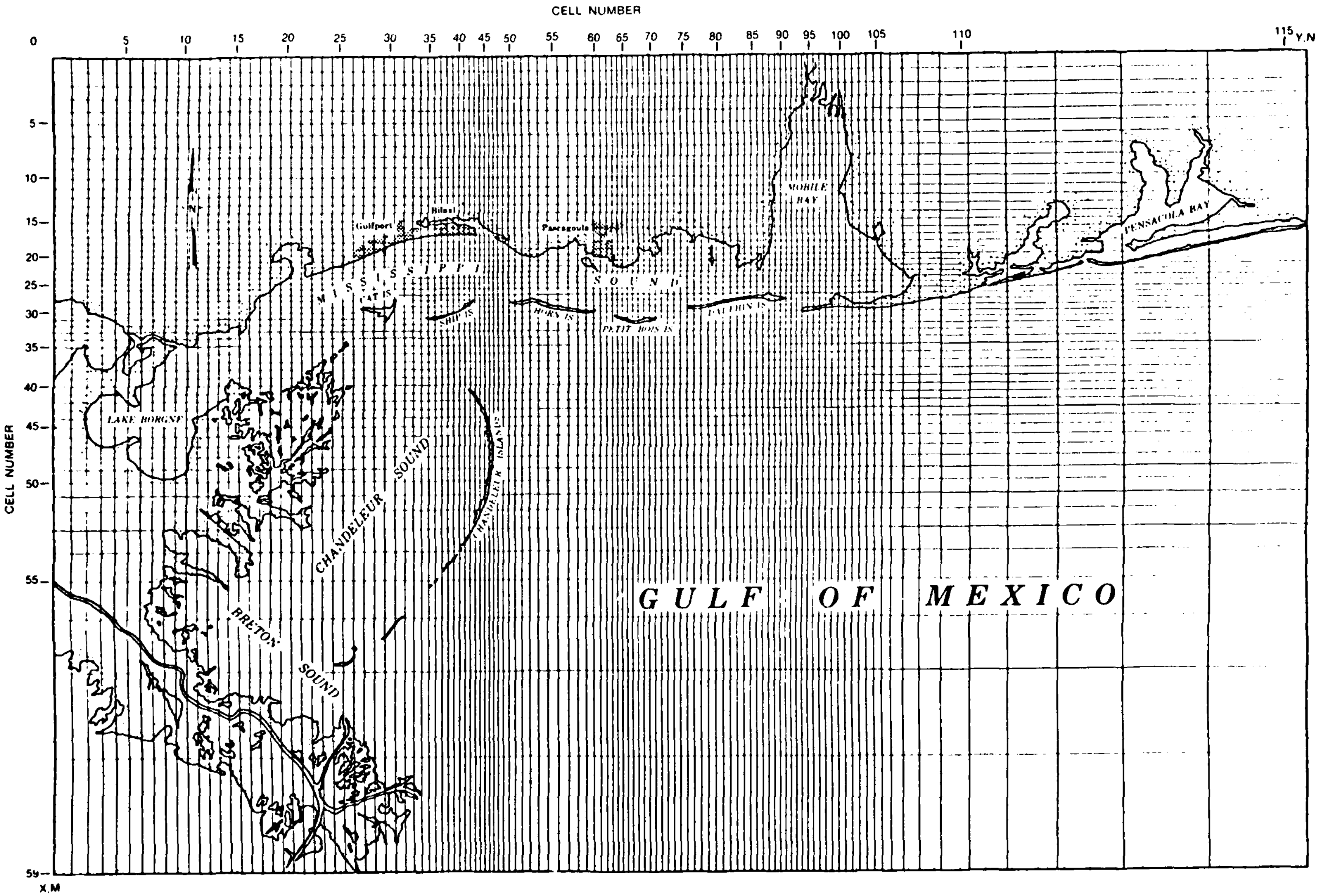

Figure 3. Mississippi Sound global grid

Lake Borgne were specified in a zone format. In this process, each succeeding step overrides the previous step values.

Table 3

Initial Salinity Conditions on the Global Grid

Water Depth ft	Initial Salinity Value, ppt
0-10	22.0
10-20	23.0
20-30	25.0
30-50	30.0
50-75	34.0
75-100	34.3
100-120	34.5
120-200	35.0
200-300	35.5
300-500	36.0

Salinity Grid-Cell-by-Grid-Cell Interpolated Limits

Patch	Global Grid Cell Range	
	N	M
1	15-27	19-39
2	28-87	15-32

Salinity Zone Specified Initial Conditions

Zone	Global Grid Cell Range		Salinity ppt
	N	M	
1	1-15	33-50	15

58. Salinity boundary conditions which remained constant over time are shown in Table 4. A cell-centered spatial interpolation similar to that employed for water surface elevations was used to determine salinity values along the seaward boundary.

Table 4

Global Grid Boundary Salinity Conditions

Tidal Signal	Global Grid Cell	Salinity Value, ppt
1	(115,58)	36
2	(115,56)	36
3	(115,50)	36
4	(115,37)	36
5	(115,22)	34
6	(31,59)	30
7	(42,59)	36
8	(57,59)	36
9	(73,59)	36
10	(87,59)	36
11	(103,59)	36
12	(110,59)	36
13	(112,59)	36
14	(115,59)	36
Freshwater Inflow		
1	(97,3)	0
2	(59,19)	24
3	(59,17)	24
4	(13,33)	15
5	(19,20)	17
6	(32,15)	23

59. Wind data reported by Raytheon Ocean Systems (1981) over the period are presented in Table 5. The spatially averaged wind speeds and directions shown were lagged 6 hr in order to investigate model sensitivity to wind. A constant drag coeffecient equal to 0.001 was used in the computations.

60. A total of 1200 time steps were used to simulate 120 hr of prototype time. Wind information input at 6-hr intervals was interpolated in time at each time step. Both salinity schemes were considered. The scheme 1 FCT results and the scheme 2 three time level results are shown in Table 6. The following previously calibrated effective dispersion coefficients are employed:

$$C_x = C_y = 10$$

$$D_x = D_y = 0$$

Reduction factor = 0.0388

Table 5

Wind Data for 20-24 Sep

Julian Day	GMT Hour	MET 1		MET 3		MET 4		MET 5		Average Speed/ Direction
		Speed	Direction	Speed	Direction	Speed	Direction	Speed	Direction	
	24	4.9	123	12.5	110	9.1	114	12.0	103	9.6/112
264	6	4.3	156	4.6	154	7.4	162	12.8	156	7.3/157
	12	4.1	154	3.4	46	3.1	122	10.3	100	5.2/105
	18	5.1	135	8.3	152	7.4	142	9.7	134	7.6/141
	24	4.7	145	6.8	156	4.5	157	7.3	152	5.8/152
265	6	4.7	141	9.3	148	7.8	142	13.3	163	8.7/148
	12	6.1	192	3.7	195	3.2	160	6.6	138	4.9/171
	18	4.8	130	8.1	158	6.5	135	6.6	144	6.5/142
	24	5.8	153	9.0	153	6.3	160	7.9	168	7.2/158
266	6	11.1	167	8.1	160	5.0	163	8.1	153	8.0/161
	12	7.1	176	4.0	184	3.7	162	7.3	148	5.5/167
	18	4.6	153	7.0	170	6.0	102	6.2	143	5.9/142
	24	6.9	154	8.9	165	6.6	167	8.0	177	7.6/166
267	6	7.0	172	4.9	181	3.0	164	3.8	171	4.6/172
	12	3.4	35	6.2	357	2.8	15	1.4	31	3.4/27
	18	4.7	123	8.7	147	9.1	87	3.9	77	6.6/108
	24	5.6	159	7.5	163	5.7	162	8.2	157	6.7/160
268	6	8.2	180	6.8	176	5.1	166	9.6	158	7.4/170
	12	2.9	147	4.1	73	3.7	161	6.2	166	4.2/137
	18	3.6	188	8.3	184	4.5	238	4.3	193	5.1/201
	24	5.2	154	7.5	156	5.4	145	8.9	156	6.7/153

Note: MET 2 was nonfunctioning this period.
MET 3 and MET 1 are "land" stations.
MET 4 and MET 5 are "island" stations.
Speed (MPH).
Direction (Magnetic).

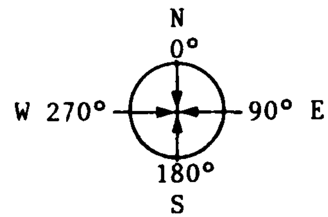

Table 6

Global Grid Wind Sensitivity Simulation

Transect Station	Global Grid Cell	20/21 Sep 1980 Measured	20/21 Sep 1980 Initial Condition	24 Sep 1980 Measured	24 Sep 1980 Computed 1	24 Sep 1980 Computed 2
T26	(15,39)	16.0	16.0	14.2	19.8	20.2
T30	(16,35)	17.0	17.0	17.2	17.4	18.4
T28	(16,38)	17.3	17.0	15.1	17.8	17.9
T32	(18,33)	17.5	17.0	17.6	17.8	17.8
T24	(18,38)	19.2	19.0	19.3	20.2	20.0
T34	(20,31)	19.2	19.0	19.5	19.3	19.4
T22	(21,35)	23.7	24.0	21.8	23.7	24.1
T36	(23,29)	21.8	22.0	21.1	21.3	20.7
T20	(24,33)	24.9	25.0	24.1	25.3	25.3
T38	(26,29)	22.0	22.0	23.1	22.2	25.8
T40	(27,24)	22.4	22.0	21.0	22.3	22.4
T18	(27,33)	26.8	27.0	25.7	24.4	23.3
T42	(29,26)	23.7	24.0	23.0	23.1	23.1
T6	(29,20)	24.0	24.0	23.8	24.1	24.1
T8	(31,23)	24.8	25.0	23.9	25.0	25.2
T10	(32,26)	25.6	26.0	25.0	24.9	25.0
T12	(33,29)	27.3	27.0	25.5	25.5	25.5
T4	(34,23)	25.2	25.0	23.9	24.5	24.3
T14	(34,31)	28.3	28.0	27.1	25.5	24.4
T16	(34,32)	28.3	28.0	26.8	26.1	26.0
T2	(40,27)	26.1	26.0	25.6	26.1	26.4
T44	(49,21)	23.6	24.0	23.4	25.2	25.3
T46	(49,24)	26.9	27.0	26.2	25.9	25.5
T48	(49,27)	28.2	28.0	27.8	27.3	28.1
T50	(49,29)	28.3	28.0	28.7	27.4	27.2
T52	(53,25)	26.3	26.0	26.7	26.1	26.1
T54	(57,28)	27.3	27.0	27.6	28.9	28.9
T64	(59,21)	27.7	28.0	27.5	27.6	28.4
T62	(60,23)	28.5	28.0	26.8	27.9	28.3
T66	(62,22)	27.3	27.0	27.7	26.9	26.7
T60	(62,24)	28.1	28.0	29.1	27.2	27.2
T58	(62,28)	29.1	29.0	29.6	28.2	28.0
T56	(62,32)	29.7	30.0	30.3	30.1	29.5
T68	(67,26)	27.9	28.0	27.5*	28.1	28.2
T70	(71,28)	28.4	28.0	29.9*	28.2	28.1
T74	(75,26)	28.1	28.0	--	28.4	28.3
T72	(75,30)	28.7	29.0	28.5*	26.2	26.8
T76	(76,25)	26.6	27.0	--	28.2	28.1
T78	(81,25)	22.5	22.0	--	22.4	22.6
T80	(86,25)	22.9	23.0	--	22.6	22.9

* 28 Sep 1980.

In regions of the Sound, the scheme 1 and scheme 2 results are nearly identical and are in agreement with the calibration simulation and measured salinity values. However, in the vicinity of the upper Mobile Bay freshwater inflow, the results diverge as shown in Table 7. The scheme 1 results are nonnegative and exhibit no oscillations. The scheme 2 results exhibit oscillations behind the freshwater front.

Refined Grid Results

61. In order to investigate the salinity distribution in the vicinity of the Pascagoula Channel, the refined grid shown in Figure 4 was developed. This grid employs 49 × 28 = 1372 cells. Maximum spatial resolution of 300 ft is employed to represent the navigation channels. The configuration of the channel system is idealized in the grid in order to reduce the number of grid cells. A 60-sec time step was used, resulting in a maximum spatial Courant number of less than 8 within the grid system.

62. The 20-24 Sep 1980 period with 6-hr lagged wind considered on the global grid was studied on the refined grid. The salinity values computed in the global grid scheme 1 FCT simulation were saved and interpolated temporally and spatially to provide the boundary conditions for the refined grid simulation. Initial conditions over the refined grid were determined from transect data and input cell by cell. Zero salinity values for the Pascagoula River System were input for cells (8,1) and (16,1) in order to establish a freshwater front.

63. A time step of 60 sec was employed 7200 times in order to simulate 120 hr of prototype time. Wind information input at 6-hr intervals from Table 5 was interpolated in time at each time step. The scheme 1 FCT scheme was selected based upon its superior performance on the global grid. Wind lagged simulation results using the calibrated effective dispersion coefficients in paragraph 60 are nearly identical to the calibration simulation results and correspond to measured values as shown in Table 8. In order to obtain an estimate of the freshwater influence and movement of the front, the salinity field at the end of the simulation is shown in Table 9. Note the scheme 1 results are nonnegative and exhibit no oscillation. The flow pattern in the vicinity of the freshwater inflow at (16,1) is extremely complex. The averaging processes employed in coupling the two time level scheme 1 FCT with

Table 7

Upper Mobile Bay Simulation Results in the Global Grid After 120 Hr

Scheme 1 (Flux Corrected Transport)

M N	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	0.	0.	0.	0.	C.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	0.	0.	[illegible]	[illegible]	0.	0.	0.	0.	0.	0.	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2200.	2216.	1763.	114.	0.	52.	274.	2263.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2200.	2207.	2136.	1620.	955.	51.	1423.	2291.	2220.	2221.
7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2200.	220C.	2194.	2087.	1557.	1036.	1592.	2200.	2276.	2243.
8	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	2201.	2200.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	0.	[illegible]	[illegible]	[illegible]	0.	[illegible]	0.	0.	0.	2200.	2200.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2170.	2276.	2293.	2294.
10	0.	0.	[illegible]	0.	[illegible]	0.	0.	0.	2201.	2200.	2209.	2226.	[illegible]	[illegible]	[illegible]	[illegible]	2277.	2288.	2269.	2260.
11	0.	0.	0.	0.	C.	0.	0.	2201.	2201.	2200.	2195.	2236.	2280.	2308.	2297.	2255.	2298.	2283.	2217.	0.
12	0.	0.	0.	0.	C.	0.	0.	2202.	2200.	2211.	2228.	2233.	2295.	2309.	2292.	2283.	2258.	2241.	2216.	0.
13	0.	0.	0.	0.	0.	0.	0.	2202.	2215.	2234.	2260.	2246.	2276.	2312.	2297.	2293.	2252.	2211.	2209.	2208.
14	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	2203.	2206.	2261.	2276.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2210.	2230.	2279.	2277.	[illegible]	[illegible]	[illegible]	[illegible]	2301.	2254.	2284.	2230.	2209.

Scheme 2 (Explicit Three Time Level)

M N	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	0.	0.	[illegible]	[illegible]	0.	0.	0.	0.	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	0.
4	0.	0.	[illegible]	[illegible]	[illegible]	0.	0.	0.	0.	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	0.
5	0.	0.	0.	0.	0	0.	0	0.	0	0.	2197.	2257.	1777.	-24.	-475.	307.	706.	2940.	0.	0.
6	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	2200.	2205.	2149.	1621.	1219.	-109.	1572.	2300.	2193.	2220.
7	0.	0.	0.	0.	0	0.	0	0	0	0.	2200.	2200.	2194.	2117.	2029.	1234.	1674.	2218.	2271.	2248.
8	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	0.	[illegible]	0.	2202.	2200.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2170.	2277.	2299.	2328.
10	0.	0.	[illegible]	[illegible]	0.	0.	0.	0.	2201.	2210.	2205.	2227.	[illegible]	[illegible]	2288.	2276.	2278.	2298.	2287.	2199.
11	0.	0.	0.	0.	0	0	0	2196	2213	2143.	2184	2235.	2263.	2324.	2304.	2330.	2337.	2286.	2166.	0.
12	0.	0.	0.	0.	0.	0.	0.	2199.	2182.	2251.	2203.	2132.	2298.	2339.	2276.	2268.	2227.	2253.	2212.	0.
13	0.	0.	0.	0.	0.	0.	0.	2202.	2217.	2229.	2315.	2256.	2286.	2317.	2290.	2263.	2249.	2163.	2209.	2195.
14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2201.	2204.	2242.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2276.	[illegible]	[illegible]
15	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	0.	2209.	2226.	2265.	2289.	[illegible]	[illegible]	[illegible]	[illegible]	2300.	[illegible]	2298.	2203.	2198.

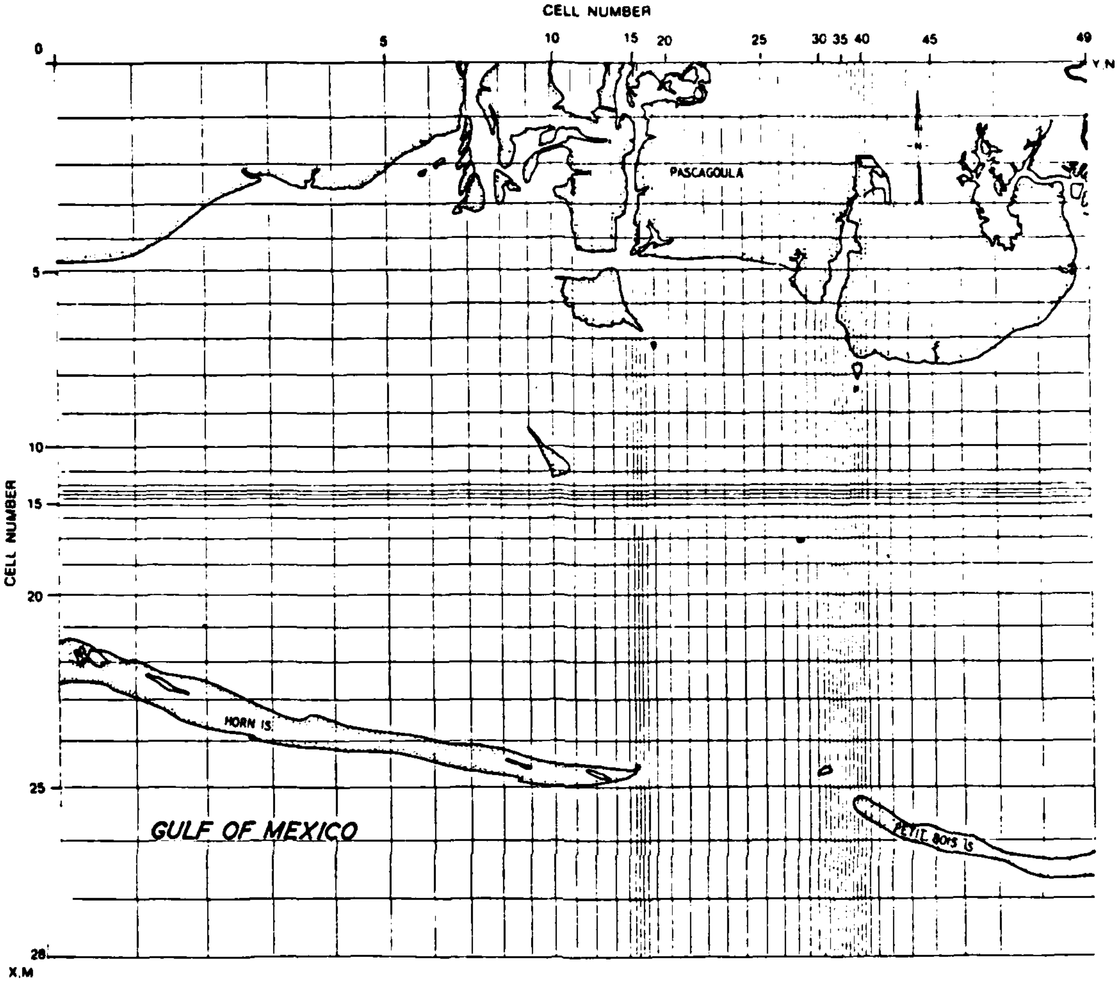

Figure 4. Pascagoula Channel System refined grid

Table 8

Refined Grid Wind Sensitivity Simulation

Transect Station	Refined Grid Cell	20/21 Sep 1980 Measured	20/21 Sep 1980 Initial Condition	24 Sep 1980 Measured	24 Sep 1980 Computed Scheme 1
T54	(8,22)	27.3	27.0	27.6	28.8
T64	(17,6)	27.7	28.0	27.5	28.3
T62	(24,9)	28.5	29.0	26.8	27.7
T66	(31,7)	27.3	27.0	27.7	27.9
T60	(33,7)	28.1	27.0	29.1	27.8
T58	(36,23)	29.1	29.0	29.6	27.7
T56	(34,26)	29.7	30.0	30.3	28.0
T68	(49,19)	27.9	28.0	27.5*	28.0

* 28 Sep 1980.

Table 9

Pascagoula River Vicinity Simulation Results After 120 Hr on the Refined Grid

Scheme 1 (Flux Corrected Transport)

M N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0	0.	2377	10	0.	2404.	2403.	0.	0.	0.	2079.	861.	2687.	0.	0.	0.
3	0.	0.	0.	0.	0.	2195.	1040.	276.	2571.	2480.	2405.	0.	0.	0.	827.	853.	1403.	0.	0.	0.
4	0.	0.	2330.	2214.	1314	1833.	1766.	1081.	2480	2474.	2563.	0.	0.	0.	2461.	741.	2183.	0.	0.	0.
5	0.	2409.	2402.	2631.	2475	2417	2671.	1467.	2530	2660.	2663.	2687.	2711.	2518.	2547.	779.	1665.	0.	0.	0.
6	2443.	2440.	2516.	2795.	2794.	2814.	2814.	2778.	2750.	2720.	2565.	0.	0.	2090.	2431.	1994.	2626.	2783.	2800.	2800.
7	2433.	2445.	2577.	2743.	2739.	2750.	2775.	2728.	2693.	2589.	2448.	0.	0.	2102.	2369.	2124.	2479.	2584.	2737.	2735.
8	2422.	2450.	2590.	2760.	2750.	2767.	2764.	2730.	2624.	2432.	2319.	2296.	2279.	2193.	2367.	1956.	1833.	1892.	2383.	2556.
9	2465.	2455.	2629.	2746.	2719	2754.	2777.	2814.	2813.	2714.	2379.	2270.	2265.	2266.	2459.	1897.	1860.	2097.	2172.	2319.
10	2459.	2464.	2700.	2731.	2700	2705.	2746	2807.	2820.	2796.	2791.	2719.	2520.	2394.	2459.	1957.	2044.	2205.	2342.	2468.
11	2545.	2546.	2724.	2712.	2701	2713	2742	2754.	2792.	2740.	0.	2605.	2601	2513.	2405.	2077.	2190.	2298.	2430.	2379.
12	2578.	2594.	2724.	2702.	2702.	2715.	2772.	2826.	2801.	2747.	2726.	2750.	2648.	2516.	2479.	2212.	2249.	2249.	2354.	2377.
13	2558.	2607.	2724.	2659.	2707.	2727.	2751.	2826.	2823.	2783.	2792.	2739.	2739.	2712.	2499.	2259.	2262.	2255.	2296.	2303.
14	2606.	2610.	2724.	2699.	2706.	2725.	2772.	2827.	2805.	2788.	2810.	2740.	2715.	2576.	2379.	2274.	2276.	2267.	2277.	2277.
15	2616.	2614.	2724.	2699.	2706	2727.	2791	2827.	2809.	2802.	2812.	2727.	2707.	2711.	2420.	2264.	2275.	2262.	2310.	2420.
16	2627.	2614.	2724.	2699.	2706.	2725.	2775.	2827.	2810.	2797.	2816.	2751.	2707.	2596.	2364.	2400.	2274.	2306.	2397.	2366.
17	2641.	2623.	2724.	2659.	2709.	2730.	2752.	2828.	2813.	2802.	2819.	2759.	2737.	2703.	2383.	2497.	2407.	2405.	2439.	2499.
18	2684.	2623.	2721.	2659.	2711.	2737.	2785.	2831.	2810.	2815.	2819.	2836.	2838.	2842.	2689.	2650.	2742.	2677.	2797.	2793.
19	2702.	2664.	2718.	2699.	2715.	2751.	2803.	2843.	2811.	2824.	2836.	2855.	2878.	2655.	2827.	2843.	2845.	2839.	2836.	2816.
20	2725.	2706.	2705.	2705.	2721.	2782.	2825.	2851.	2814.	2829.	2838.	2868.	2885.	2879.	2863.	2866.	2856.	2853.	2838.	2828.
21	2698.	2697.	2702.	2705.	2731.	2811.	2836.	2867.	2845.	2894.	2898.	2885.	2892.	2889.	2870.	2867.	2854.	2851.	2840.	2836.
22	2669.	2655.	2702.	2710.	2752	2847.	2864	2860.	2878.	2915.	2906.	2896.	2918	2891.	2676.	2876.	2870.	2873.	2973.	2999.
23	0.	0.	2702.	2716.	2771.	2876.	2876.	2914.	2923.	2931.	2906.	2910.	2937.	2929.	2918.	2923.	2915.	2919.	2909.	2911.
24	2693.	2701.	0.	2730.	2792.	2874.	2856.	2913.	2943.	2948.	2944.	2931.	2947.	2946.	2950.	2941.	2947.	2939.	2943.	2934.
25	2746.	2792.	2861.	2907.	2835.	2873.	0.	0.	2923.	2945.	2953.	2954.	2957.	2956.	2953.	2953.	2956.	2952.	2948.	2937.
26	2772.	2949.	3011.	2930.	2916.	2986.	2946.	2963.	2974.	2977.	2970.	2970.	2971.	2964.	2966.	2967.	2968.	2969.	2968.	2970.
27	2831.	2973.	3019.	3019.	2987.	2986.	2981	2988.	2985.	2978.	2976.	2975.	2982.	2994.	2996.	2996.	2997.	2997.	2997.	3000.
28	3040.	2970.	2998.	3024.	2990.	2992.	2993.	2994.	2991.	2989.	2987.	2980.	2973.	2967.	2964.	2962.	2960.	2960.	2960.	2960.

the three time level hydrodynamics may contribute to the unusual distribution over cells (15-17,1). These effects are usually local and the two time level scheme 1 FCT resolves the edge of the freshwater front. Additional research is warranted to flux-correct scheme 2 thereby eliminating the above averaging of hydrodynamic variables necessary in scheme 1.

64. The input data for this simulation are presented in Appendix C. Typical output from the salinity computations embodied within WIFM is shown in Appendix D.

Computer Requirements

65. The resources required for both the hydrodynamics and the salinity computations are shown in Table 10. Scheme 1 is more accurate but requires nearly three times more computer time than does scheme 2. In general a very large scientific computation oriented machine should be utilized for applications employing the number of cells in the Mississippi Sound study.

Table 10

CRAY I-S Requirements

Simulation	Grid	Number of Time Steps	Total Field Length (Octal)	CPUS
Scheme 1 (FCT)	Global	1200	1606064	619
Scheme 1 (FCT)	Refined	7200	776152	777
Scheme 2 (Three Time Level)	Global	1200	1601756	340
Scheme 2 (Three Time Level)	Refined	7200	776266	475

66. The job control language (JCL) for a global grid and refined grid simulation is presented in Appendix E. It should be noted that the JCL shown is for the CRAY I-S Cray Operating System 1.09 as implemented at Kirtland Air Force Base, New Mexico.

REFERENCES

Butler, H. L. 1980. "Evolution of a Numerical Model for Simulating Long-Period Wave Behavior in Ocean-Estuarine Systems," Estuarine and Wetland Processes, Hamilton, P., and Macdonald, K., eds., Plenum Press, New York.

Elder, J. W. 1959. "The Dispersion of Marked Fluid in Turbulent Shear Flow," Journal of Fluid Mechanics, Vol 5, p 544.

Harleman, D., et al. 1959. "The Diffusion of Two Fluids of Different Density in a Homogeneous Turbulent Field," Technical Report No. 31, Massachusetts Institute of Technology, Hydrodynamics Laboratory, Cambridge, Mass.

Raytheon Ocean Systems. 1981. "Final Report Mississippi Sound Data Collection Program" (Draft), submitted to U. S. Army Corps of Engineers, Mobile District, Mobile, Ala.

Reid, R. O., and Whitaker, R. E. 1981. "Numerical Model for Astronomical Tides in the Gulf of Mexico," Contract DACW39-79-C-0074, prepared for U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

Schmalz, R. A. 1983a. "The Development of a Numerical Solution to the Transport Equation: Methodology," Miscellaneous Paper CERC-83-2, Report 1, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

__________. 1983b. "The Development of a Numerical Solution to the Transport Equation: Computational Procedures," Miscellaneous Paper CERC-83-2, Report 2, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

__________. 1983c. "The Development of a Numerical Solution to the Transport Equation: Test Results," Miscellaneous Paper CERC-83-2, Report 3, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

__________. 1984. "Numerical Model Investigation of Mississippi Sound and Adjacent Areas," Technical Report, in preparation, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

Taylor, G. I. 1954. "Dispersion of Matter in Turbulent Flow Through a Pipe," Proceedings of Royal Society of London (A), Vol 223.

Zalesak, S. T. 1979. "Fully Multi-Dimensional Flux-Corrected Transport Algorithms for Fluids," Journal of Computational Physics, Vol 31, pp 333-362.

APPENDIX A: SUBROUTINE LISTINGS

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 1. CLIRK LIST                                                                CAL.453
 2.        SUBROUTINE CCNC                                                    CCNC.2
 3.        PARAMETER (ND=5,N6=60)                                             CCNC.3
 4.        PARAMETER (NUMPT=1372,NDIM=45,MDIM=28,NFPTS=1)                     CAL.5
 5.        PARAMETER (IFRC=205,IDXS=20,IFLT=1,ITCS=40,JPUT=7205,JFLS=2)       CAL.6
 6.        LOGICAL ITAFL,IPT,IDUMP                                            SCALAR.2
 7.        COMMON /V1/ MMAX,NMAX,NTIL,NFLC,ITIL,JTIL,INITL,NP1,NP2,NP3,NPR,   SCALAR.3
          1 MFR,MAXTIM,INTAF,IDELAY,IFLCT,NGAGE,N1,M1,NX1,MX1,ISTEP,KK,       SCALAR.4
          2 ITIME,IP1,IPF,NFREQ,IRECK,IXFAN,NPX,MSURF,NXX,NYY,N2P,NDTAP,      SCALAR.5
          3 JFO,KREST,KS1,KS2,KS3,KS4,KS5,KS6,NNPCT,MSKP,MOLY,ITAPE,IPT,      2/2/81.1
          4 IDUMP,INC,KBT,KFT,KTT,ITYP,INCX,ICIR,KUV,KTRANS,NBG,MEG,KSB       SCALAR.7
          5 ,IRESTP,NCCNT,IOVER,IFLVL,NN,INFT,NSTP,NTSW,NWAT,NAL,MLIM         SCALAR.8
          6 ,NS2,MS2,LEVEL,MEX,NZO,NCCNAT,IVFLCT,ICFLCT,IHOT,ISLRG,NTABLE,    SCALAR.9
          7 IPSND,NCHAN,KCS,ITRM,ICLCL,KCH,NDMX                               SCALAR.10
          8  ,NCON                                                            12/22/81.1
 8.        COMMON /V2/ TAL,DT,CX,DY,CX2,CY2,G,G2,ALAT,XI,WA,THETA,EPSO,       SCALAR.11
          1 EPSD2,EPSD3,EPSD4,EPSD6,DCCN1,RCTA,SIXTH,F1,PI180,TSX,TSY,        SCALAR.12
          2 ADV,VIS,DMEX,DMAXC,SINIT,AFSD,IPRC,TPE,                           SCALAR.13
          3 YLAND,XSCCLN,SMAX,TZ1,TALX,TAUY,FF,DXF,DYF,ZN1,ZN2                SCALAR.14
          4 ,XU,YU,XL1,YL1,DCCN2,WATERR,CLIMIT                                 SCALAR.15
          5 ,GTSX,GTSY,EGT,EGT2,FF2,GCDX,GCDY,G2T,GT,XI2                      SCALAR.16
          6  ,FXS,FYS,FATMS,ISAL,ISALS,ISALC,CMAX,XMS,IFETR                   CAL.1
 9.        COMMON/V6/ IBARX(200),IBARY(200),IBART(200),IBARR(200,5),          FLODRY.2
          1  ITIDE(200),IFLCG(200),ITRAPS(20),ICHAN(10),XCHAN(200,2)          FLODRY.3
          1    ,INT(200),F1(200),ITC1(200),ITC2(200)                          12/22/81.4
10.        COMMON /V7/ XMAN(20),ZB(20),CE(20),CC(20),CAYD(20),CD(20)          FLODRY.4
          *    ,CARPY1(20),CARPY2(20)                                         FLODRY.5
11.        COMMON /AA4/ IFLOOD(NFPTS),ZFU(NFPTS),ZFV(NFPTS),CHZ(NFPTS),       FLODRY.6
          1  IPAS(NFPTS)                                                      FLODRY.7
12.        DIMENSION JFLCD(NFPTS)                                             FLODRY.8
13.        EQUIVALENCE (JFLOD(1),CHZ(1))                                      FLODRY.9
14.        COMMON /AA1/ SEF(NDIM,MDIM),SE(NDIM,MDIM),SEM(NDIM,MDIM)           EUVHC2D.2
15.        COMMON /AA2/ UF(NDIM,MDIM),U(NDIM,MDIM),UM(NDIM,MDIM),F(NDIM,MDIM) EUVHC2D.3
16.        COMMON /AA3/ VP(NDIM,MDIM),V(NDIM,MDIM),VM(NDIM,MDIM),C(NDIM,MDIM) EUVHC2D.4
17.        COMMON /AA7/ FRIC(IFRC,IDXS),SURFE(IPUT,ITCS),CCHRGE(JFUT,JFLS)    ARRAY.2
          2  ,CONE(IFLT,ITCS),COND(JFLT,JFLS)                                 TEST.1
18.        COMMON /AA5/ ICU(NDIM,MDIM),ICV(NDIM,MDIM),JSB(NDIM,MDIM)          ARRAY2D.2
19.        COMMON /AA6/ FXX(NDIM,MDIM),FYY(NDIM,MDIM),PFEL(NDIM,MDIM),        ARRAY2D.3
          1  ISTORE(NDIM,MDIM)                                                ARRAY2D.4
20.        DIMENSION PTAB(1,1)                                                ARRAY2D.5
21.        EQUIVALENCE (PTAB(1,1),ICU(1,1))                                   ARRAY2D.6
22.         COMMON/V15/GL1(500),GL2(500),GL3(500),GL4(500),GL5(500)           MISC.2
23.        COMMON/V8/ NV(150),XMU(300),YML(300),IIBAY(20),NBAY(20),R1(20),    MISC.3
          1              R2(20),AS(20),ALL(20)                                MISC.4
          1  ,XMUT(300),YMUT(300)                                             MISC.5
24.        COMMON /V9/ A(150),B(150),P(150),Q(150),R(150),S(150),ISB(150)     MISC.6
          1  ,D1(150),FX(150),FY(150),PAIM(150),VISC(150),ADVE(150),ADVC(150) MISC.7
25.        COMMON /V10/ IL1(150),IL2(150),IV1(150),IV2(150)                   MISC.8
          1  ,NOBD(300),NCLGB,TME1,TME2,TME3,TME4                             CAL.3
26.        COMMON /V11/ TMUC(150),ILCN(50),LCX(50),MDX(50)                    MISC.10
          1  ,WAT(50),TPT(50),NCARD(50)                                       MISC.11
27.        INTEGER COAST                                                      MISC.12
28.        COMMON /AA8/ SGRID(1,1),IGRIL(1,1),CCAST(1),SURPLT(1,1)            MISC.13
29.        COMMON/CALC/TMF1(150),TMF2(150),TMF3(150),TMF4(150),TMF5(150),     TEST.4
          1  TMF6(150)                                                        TEST.5
30.        DIMENSION AL(150),BL(150),APL(150),AML(150),CK(150)                CAL.4
          1  ,UT(150)                                                         12/22/81.6
31.        EQUIVALENCE (AL(1),A(1)),(BL(1),B(1)),(APL(1),VISC(1)),            12/22/81.7
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 4533              1  (APL(1),ACVE(1)),(UK(1),ADVC(1)),(CI(1),FX(1))    12/22/81.8
 4534   32.        DIMENSION APH(150),APH(150),AH(150),EH(150)          12/22/81.9
 4535   33.        EQUIVALENCE (APH(1),TMP1(1)),(APH(1),TMP2(1)),(AH(1),TPPS(1)),  12/22/81.10
 4536              1 (BH(1),TPP4(1))                                   12/22/81.11
 4537   34.        COMMON/EMASS/AE(2),SUMB(2),SUPTB                     12/22/81.12
 4538   35.        COMMON/CONC/CN(NDIP,MDIP),CPL(NLIP,PCIP),CNPL(NDIM,MCIP),   12/22/81.17
 4539              1  CPH(NLIM,PCIP),CNPH(NLIP,PCIP),CX(NDIP,MCIP),CY(NDIM,PLIM),   12/22/81.18
 4540              2  DKYX(NDIP,MDIP),DKYY(NDIP,MDIM),FLLX(NDIP,MDIM),FLLY(NDIP,MDIP)  12/22/81.19
 4541              3,RM(NDIM,MDIM),RP(NDIM,MDIM)                       CAL.8
 4542   36.        COMMON/COPT/IDEBUG,ALL,BLU,NLL,MLU                   CAL.454
 4543   37.        MM=MAX0(KK-1,1)                                      12/22/81.236
 4544   38.        IF(NFLC.EQ.0)GC TC 50                                12/22/81.237
 4545   39.        DO 60 I=1,KCV                                        12/22/81.238
 4546   40.        IP=IFLO(I)                                           CONC.23
 4547   41.        INDX=IP/1000000                                      CONC.24
 4548   42.        IP=IP-1000000*INDX                                   CONC.25
 4549   43.        N=IP/1000                                            CONC.26
 4550   44.        M=IP-1000*N                                          CONC.27
 4551   45.        INDX=INDX-INDX/100*100                               CONC.28
 4552   46.        IDIR=INDX/10                                         CONC.29
 4553   47.        INDX=INDX-10*IDIR                                    CONC.30
 4554   48.        T1=(COND(KK,INDX)+COND(MM,INDX))*.5                  12/22/81.239
 4555   49.        T2=COND(KK,INDX)                                     12/22/81.240
 4556   50.        IF(KK-1.EQ.ISALC)CN(N,M)=CONE(MM,INDX)               CAL.455
 4557   51.        CPL(N,M)=T1                                          12/22/81.241
 4558   52.        CPH(N,M)=T1                                          12/22/81.242
 4559   53.        CNPL(N,M)=T2                                         12/22/81.243
 4560   54. 60     CNPH(N,M)=T2                                         12/22/81.244
 4561   55. 50     IF(NTID.EQ.0)GO TO 100                               12/22/81.245
 4562   56.        DO 70 I=1,KIT                                        12/22/81.246
 4563   57.        IP=ITILE(I)                                          CONC.37
 4564   58.        INDX=IP/1000000                                      CONC.38
 4565   59.        IP=IP-1000000*INDX                                   CONC.39
 4566   60.        N=IP/1000                                            CONC.40
 4567   61.        M=IP-1000*N                                          CONC.41
 4568   62.        IF(INT(I))6005,6006,6005                             CAL.456
 4569   63. 6005   T1=(1.-FI(I))*CONE(MM,ITG1(I))+FI(I)*CONE(MM,ITG2(I))   CAL.457
 4570   64.        T2=(1.-FI(I))*CONE(KK,ITG1(I))+FI(I)*CONE(KK,ITG2(I))   CAL.458
 4571   65.        IF(KK-1.EQ.ISALC)CN(N,M)=T1                          CAL.459
 4572   66.        T1=.5*(T1+T2)                                        CAL.460
 4573   67.        GO TO 6010                                           CAL.461
 4574   68. 6006   INDX=INDX-INDX/100*100                               CAL.462
 4575   69.        IDIR=INDX/10                                         CONC.43
 4576   70.        INDX=INDX-10*IDIR                                    CONC.44
 4577   71.        T1=(CONE(KK,INDX)+CONE(MM,INDX))*.5                  12/22/81.247
 4578   72.        T2=CONE(KK,INDX)                                     12/22/81.248
 4579   73.        IF(KK-1.EQ.ISALC)CN(N,M)=CONE(MM,INDX)               CAL.463
 4580   74. 6010   CPL(N,M)=T1                                          CAL.464
 4581   75.        CPH(N,M)=T1                                          12/22/81.250
 4582   76.        CNPL(N,M)=T2                                         12/22/81.251
 4583   77. 70     CNPH(N,M)=T2                                         12/22/81.252
 4584   78. 100    IF(NGLOB.EQ.0)GO TO 105                              CAL.465
 4585   79.        IF(TME-TME4)102,102,103                              CAL.466
 4586   80. 103    TME3=TPL4                                            CAL.467
 4587   81.        DO 104 I=1,NGLCB                                     CAL.468
 4588   82. 104    GL4(I)=GL5(I)                                        CAL.469
 4589   83.        READ(34)TME4,(GL5(I),I=1,NGLCB)                      CAL.470
 4590   84. 102    [illegible] I=1,NGLCB [illegible]                    CAL.471
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4591    85. 100   GL3(I)=GL4(I)+(TME-TME3)*(GL5(I)-GL4(I))/(TME4-TME3)          CAL.472
4592    86.       IF(IPT)PRINT 5005,TME3,(GL4(I),I=1,NGLCB)                     CAL.473
4593    87.       IF(IPT)PRINT 5005,TME4,(GL5(I),I=1,NGLCB)                     CAL.474
4594    88. 5005  FORMAT(4  TIME (GG) ,F8.2,1X,GLOBAL GRID SALINITY LEVELS,/,   CAL.475
4595    89.      1  (5X,10(F6.2,5X),/))                                         CAL.476
4596    89.       IF(IPT)PRINT 5000,TPE,(GL3(I),I=1,NGLCB)                      CAL.477
4597    90. 5000  FORMAT(  TIME ,F6.2,1X,TIME INTR. GLOBAL GRID SALINITY,/,     CAL.478
4598             1  (5X,10(F6.2,5X),/))                                         CAL.479
4599    91.       DO 106 I=1,KTT                                                CAL.480
4600    92.       IP=ITIDE(I)                                                   CAL.481
4601    93.       INDX=IP/1000000                                               CAL.482
4602    94.       IP=IP-1000000*INDX                                            CAL.483
4603    95.       N=IP/1000                                                     CAL.484
4604    96.       M=IP-1000*N                                                   CAL.485
4605    97.       T1=CN(N,M)                                                    CAL.486
4606    98.       T2=(1.-FI(I))*GL3(ITG1(I))+FI(I)*GL3(ITG2(I))                 CAL.487
4607    99.       CFL(N,M)=(T2+T1)*.5                                           CAL.488
4608    100.      CPH(N,M)=CFL(N,M)                                             CAL.489
4609    101.      CNPL(N,M)=T2                                                  CAL.490
4610    102. 106  CNPH(N,M)=T2                                                  CAL.491
4611    103. 105  DO 4001 M=1,MMAX                                              CAL.492
4612    104.      IU2(M)=ICU(1,M)/10                                            CONC.50
4613    105. 4001 IV2(M)=ICV(1,M)/10                                            CONC.51
4614         C    BEGIN FIRST CYCLE -- LOOP ON N                                CONC.52
4615    106.      DO 77 N=2,N1                                                  CONC.53
4616    107.      TSYY=.5*TSY/YNU(2*N-1)                                        CONC.54
4617    108.      TSYYM=1./(YNU(2*N-2)*DY)                                      12/22/81.254
4618    109.      TSYYP=1./(YNU(2*N)*DY)                                        12/22/81.255
4619    110.      DO 130 M=1,MMAX                                               CONC.61
4620    111.      IU1(M)=IU2(M)                                                 CONC.62
4621    112.  130 IV1(M)=IV2(M)                                                 CONC.63
4622    113.      DO 4002 M=1,MMAX                                              CONC.64
4623    114.      IU2(M)=ICU(N,M)/10                                            CONC.65
4624    115. 4002 IV2(M)=ICV(N,M)/10                                            CONC.66
4625    116.      MG=1                                                          CONC.67
4626         C    FIND BEGINNING OF COMPUTATIONAL LINE                          CONC.69
4627    117. 25   DO 110 MZ=MC,MMAX                                             12/22/81.256
4628    118.      MM=MZ                                                         CONC.74
4629    119.      L1=IU2(MZ)                                                    CONC.75
4630    120.      IF(L1.LT.1.OR.L1.GT.9) GO TO 351                              CONC.76
4631    121.      GO TO(114,114,351,111,114,111,110,113,115),L1                 CONC.77
4632    122.  114 IF((IV2(MZ).EQ.0).OR.(IV1(MZ).EQ.0)) GO TO 195                CONC.78
4633    123.      IF((IV2(MZ).EQ.4).OR.(IV1(MZ).EQ.4)) GO TO 195                CONC.79
4634    124.  110 CONTINUE                                                      CONC.80
4635    125.      GO TO 77                                                      CONC.81
4636    126.  111 IBF=1                                                         CONC.82
4637    127.      MS=MM                                                         CONC.83
4638    128.      GO TO 119                                                     CONC.84
4639    129.  113 IBF=2                                                         12/22/81.257
4640    130.      MS=MM+1                                                       CONC.86
4641    131.      GO TO 119                                                     CONC.87
4642    132.  115 IBF=3                                                         12/22/81.258
4643    133.      MS=MM+1                                                       CONC.89
4644    134.  119 MSS=MS-1                                                      CONC.90
4645    135.      DO 118 M=1,MMAX                                               CONC.94
4646    136.      TMP5(M)=0.                                                    CONC.95
4647    137.  118 TMP6(M)=0.                                                    CONC.96
4648         C    FIND END OF LINE                                              CONC.97
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 4649   138.         DC 120 PZ=PS,PMAX                                              CONC.98
 4650   139.         MM=NZ                                                          CONC.99
 4651   140.         L1=IU2(PZ)                                                     CONC.100
 4652   141.         IF(L1.LT.1.OR.L1.GT.9) GO TO 351                               CONC.101
 4653   142.         GO TO (121,121,351,124,121,120,120,123,125),L1              12/22/81.259
 4654   143. 124     IQ=ICU(N,MM)-L1*10                                             CONC.104
 4655   144.         TMP5(PZ)=CH(IQ)                                                CONC.105
 4656   145.         TMP6(PZ)=AMAX1((SE(N,MM)+SE(N,MM+1))*.5-ZE(IQ),APSC)           CONC.106
 4657   146.   120 CONTINUE                                                         CONC.107
 4658   147.       PRINT 6000,N,MS,ITIME                                            CONC.108
 4659   148. 6000  FORMAT(* N MS ITIME *,3I10)                                      CONC.109
 4660   149.       STOP                                                             CONC.110
 4661   150.   121 IBL=1                                                            CONC.111
 4662   151.       ME=MM                                                            CONC.112
 4663   152.       GO TO 129                                                        CONC.113
 4664   153.   123 IBL=2                                                         12/22/81.260
 4665   154.       ME=MM-1                                                          CONC.115
 4666   155.       GO TO 129                                                        CONC.116
 4667   156.   125 IBL=3                                                         12/22/81.261
 4668   157.       ME=MM-1                                                          CONC.118
 4669   158.   129 MEL=ME+1                                                         CONC.119
 4670       C    SET BOUNDARY CONDITION AT BEGINNING                                CONC.123
 4671   155.       GO TO (140,142,142),IBF                                          CONC.124
 4672   160.   140 P(MSS)=0.                                                        CONC.125
 4673   161.       Q(MSS)=0.                                                        CONC.126
 4674   162.       R(MSS)=1.                                                     12/22/81.262
 4675   163.       S(MSS)=0.                                                     12/22/81.263
 4676   164.       GO TO 150                                                        CONC.127
 4677   165.   142 P(MSS)=0.                                                        CONC.128
 4678   166.       Q(MSS)=CPL(N,MSS)                                             12/22/81.264
 4679   167.       R(MSS)=0.                                                     12/22/81.265
 4680   168.       S(MSS)=CPH(N,MSS)                                             12/22/81.266
 4681   169.   150 DO 167 M=MSS,ME                                               12/22/81.267
 4682   170.       DI(M)=CVMGN(TMP6(M),.25*(SE(N,M)+SE(N,M+1)+SEP(N,M)+SEP(N,M+1))-.512/22/81.268
 4683            1+(H(N,M)+H(N,M+1)),TMP6(M))                                    12/22/81.269
 4684   171.       CBAR=CVMGN(2.*TMP5(M), C(N,M)+C(N,M+1) ,TMP5(M))              12/22/81.270
 4685   172.       TI=UF(N,M)*U(N,M)                                             12/22/81.271
 4686   173.       UT(M)=TI                                                      12/22/81.272
 4687   174.   167 DK(M)=CX(N,M)+ABS(TI)*DI(M)/CBAR+CVMGZ(0.,DKXX(N,M),TI)       12/22/81.273
 4688   175.       DO 160 M=MS,ME                                                   CONC.142
 4689   176.       DBAR1=SE(N,M)+SE(N+1,M)-H(N,M)-H(N+1,M)                          CONC.143
 4690   177.       DKY=CY(N,M)+ABS(V(N,M))*DBAR1/(C(N+1,M)+C(N,M))+CVMGZ(C.,DKYY(N,M)12/22/81.274
 4691            1,V(N,M))                                                       12/22/81.275
 4692   178.       DBAR2=SE(N,M)+SE(N-1,M)-H(N,M)-H(N-1,M)                          CONC.146
 4693   179.       DKYM=CY(N-1,M)+ABS(V(N-1,M))*DBAR2/(C(N-1,M)+C(N,M))          12/22/81.276
 4694            1+CVMGZ(0.,DKYY(N-1,M),V(N-1,M))                                12/22/81.277
 4695   180.       TSXX=.5*TSX/XPU(2*M-1)                                           CONC.149
 4696   181.       TSXXP=1./(XPU(2*M-2)*DX)                                      12/22/81.278
 4697   182.       TSXXF=1./(XPU(2*M)*DX)                                        12/22/81.279
 4698   183.       C1=.5*UT(M-1)                                                 12/22/81.280
 4699   184.       C2=.5*UT(M)                                                   12/22/81.281
 4700   185.       V1=AMAX1(0.,C1)                                               12/22/81.282
 4701   186.       V2=AMIN1(0.,C2)                                               12/22/81.283
 4702   187.       V3=AMIN1(0.,C1)                                               12/22/81.284
 4703   188.       V4=AMAX1(0.,C2)                                               12/22/81.285
 4704   189.       C1=2.*CVMGF(CN(N,M),CN(N+1,M),V(N,M))                         12/22/81.286
 4705   190.       C2=2.*CVMGF(CN(N-1,M),CN(N,M),V(N-1,M))                       12/22/81.287
 4706   191.       TP1=-TSXX*DI(M-1)*[illegible]                                 12/22/81.288
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192.        TP2=DK(M-1)*TSXXM                                            12/22/81.289
193.        TP3=TSXX*D1(M)                                               12/22/81.290
194.        TP4=DK(M)*TSYXP                                              12/22/81.291
195.        TP5=.5*(SE(N,M)+SEP(N,M))-F(N,M)                             12/22/81.292
196.        TP6=(SE(N,M)-H(N,M))*CN(N,M)                                 12/22/81.293
197.        TP7=2.*CKY*(CN(N+1,M)-CN(N,M))*TSYYP                         12/22/81.294
198.        TP8=2.*CKYP*(CN(N,M)-CN(N-1,M))*TSYYP                        12/22/81.295
199.        APL(M)=TP1*(V1+TP2)                                          12/22/81.296
200.        APL(M)=TP3*(V2-TP4)                                          12/22/81.297
201.        AL(M)=TP5+TSXX*(D1(M)*(V4+TP4)-C1(M-1)*(V3-TP2))             12/22/81.298
202.        BL(M)=TP6-.25*TSYY*(DBAR1*(C1*V(N,M)-TP7)                    12/22/81.299
          1   -DBAR2*(C2*V(N-1,M)-TP8))                                  12/22/81.300
203.        V1=.25*UT(M-1)                                               12/22/81.301
204.        V2=.25*UT(M)                                                 12/22/81.302
205.        C1=CN(N+1,M)+CN(N,M)                                         12/22/81.303
206.        C2=CN(N-1,M)+CN(N,M)                                         12/22/81.304
207.        AMM(M)=TP1*(V1+TP2)                                          12/22/81.305
208.        APM(M)=TP3*(V2-TP4)                                          12/22/81.306
209.        AM(M)=TP5+TSXX*(D1(M)*(V2+TP4)-C1(M-1)*(V1-TP2))             12/22/81.307
210.  160   BM(M)=TP6-.25*TSYY*(DBAR1*(C1*V(N,M)-TP7)-DBAR2*(C2*V(N-1,M)-TP8))12/22/81.308
211.        DO 4160 M=PS,ME                                              CONC.196
212.        C1=1./(AL(M)-APL(M)*P(M-1))                                  12/22/81.309
213.        P(M)=APL(M)*C1                                               12/22/81.310
214.        Q(M)=(BL(M)-APL(M)*Q(M-1))*C1                                12/22/81.311
215.        C2=1./(AM(M)-APM(M)*R(M-1))                                  12/22/81.312
216.        R(M)=APM(M)*C2                                               12/22/81.313
217.  4160  S(M)=(BM(M)-AMM(M)*S(M-1))*C2                                12/22/81.314
      C     BOUNDARY CONDITION AT UPPER END                              CONC.203
218.        GO TO (170,180,180),IBL                                      12/22/81.315
219.  170   CPL(N,ME)=0.                                                 12/22/81.316
220.        CPM(N,ME)=0.                                                 12/22/81.317
221.  180   DO 181 J=MS,ME                                               12/22/81.318
222.        M=ME+MS-J                                                    12/22/81.319
223.        CPL(N,M)=-P(M)*CPL(N,M+1)+Q(M)                               12/22/81.320
224.  181   CPM(N,M)=-R(M)*CPM(N,M+1)+S(M)                               12/22/81.321
225.        MO=ME                                                        12/22/81.322
226.        GO TO 186                                                    12/22/81.323
      C     COMPUTATIONAL LINE DEGENERATES TO A SINGLE CELL              CONC.210
227.  185   DBAR1=SE(N,MM)+SE(N+1,MM)-F(N,MM)-F(N+1,MM)                  12/22/81.324
228.        DKY=CY(N,MM)*ABS(V(N,MM))*DBAR1/(C(N+1,MM)+C(N,MM))          12/22/81.325
          1   +CVMGZ(0.,DKYY(N,MM),V(N,MM))                              CAL.493
229.        DBAR2=SE(N,MM)+SE(N-1,MM)-F(N,MM)-F(N-1,MM)                  CONC.216
230.        DKYM=CY(N-1,MM)*ABS(V(N-1,MM))*DBAR2/(C(N-1,MM)+C(N,MM))     12/22/81.327
          1   +CVMGZ(0.,DKYY(N-1,MM),V(N-1,MM))                          12/22/81.328
231.        TP5=1./(.5*(SE(N,MM)+SEP(N,MM))-F(N,MM))                     12/22/81.329
232.        TP6=(SE(N,MM)-H(N,MM))*CN(N,MM)                              12/22/81.330
233.        TP7=2.*CKY*(CN(N+1,MM)-CN(N,MM))*TSYYP                       12/22/81.331
234.        TP8=2.*CKYP*(CN(N,MM)-CN(N-1,MM))*TSYYP                      12/22/81.332
235.        C1=2.*CVMGP(CN(N,MM),CN(N+1,MM),V(N,MM))                     12/22/81.333
236.        C2=2.*CVMGP(CN(N-1,MM),CN(N,MM),V(N-1,MM))                   12/22/81.334
237.        CPL(N,MM)=(TP6-.25*TSYY*(DBAR1*(C1*V(N,MM)-TP7)              12/22/81.335
          1   -DBAR2*(C2*V(N-1,MM)-TP8)))*TP5                            12/22/81.336
238.        C1=CN(N+1,MM)+CN(N,MM)                                       12/22/81.337
239.        C2=CN(N-1,MM)+CN(N,MM)                                       12/22/81.338
240.        CPM(N,MM)=(TP6-.25*TSYY*(DBAR1*(C1*V(N,MM)-TP7)              12/22/81.339
          1   -DBAR2*(C2*V(N-1,MM)-TP8)))*TP5                            12/22/81.340
241.        MO=MM+1                                                      CONC.248
242.  186   IF(MO.LT.MMAX) GO TO 25                                      CONC.258
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4765  243.    77 CONTINUE                                         CONC.255
4766  244.       DO 4003 N=1,NMAX                                 12/22/81.341
4767  245.       IU2(N)=ICU(N,1)/10                               CONC.292
4768  246. 4003  IV2(N)=ICV(N,1)/10                               CONC.293
4769      C   BEGIN SECOND CYCLE ---LOOP ON P                     CONC.294
4770  247.       DO 68 M=2,MI                                     CONC.295
4771  248.       TSXA=.5*TSX/XPU(2*M-1)                           CONC.296
4772  249.       TSXAP=1./(XPU(2*M-2)*DX)                         12/22/81.342
4773  250.       TSXXP=1./(XPU(2*M)*DX)                           12/22/81.343
4774  251.       DO 230 N=1,NMAX                                  CONC.303
4775  252.       IU1(N)=IU2(N)                                    CONC.304
4776  253.   230 IV1(N)=IV2(N)                                    CONC.305
4777  254.       DO 4004 N=1,NMAX                                 CONC.306
4778  255.       IU2(N)=ICU(N,M)/10                               CONC.307
4779  256. 4004  IV2(N)=ICV(N,M)/10                               CONC.308
4780  257.       NO=1                                             CONC.309
4781      C   FIND BEGINNING OF COMPUTATIONAL LINE                CONC.311
4782  258. 35    DO 210 NZ=NC,NMAX                                12/22/81.344
4783  259.       NN=NZ                                            CONC.316
4784  260.       LI=IV2(NZ)                                       CONC.317
4785  261.       IF(LI.LT.1.OR.LI.GT.9) GO TO 351                 CONC.318
4786  262.       GO TO (214,214,391,211,214,211,210,213,215),LI   CONC.319
4787  263.   214 IF((IU2(NZ).EQ.6).OR.(IU1(NZ).EQ.6)) GO TO 285   CONC.320
4788  264.       IF((IU2(NZ).EQ.4).OR.(IU1(NZ).EQ.4)) GO TO 285   CONC.321
4789  265.   210 CONTINUE                                         CONC.322
4790  266.       GO TO 68                                         CONC.323
4791  267.   211 IBF=1                                            CONC.324
4792  268.       NS=NN                                            CONC.325
4793  269.       GO TO 219                                        CONC.326
4794  270.   213 IBF=2                                            12/22/81.345
4795  271.       NS=NN+1                                          CONC.328
4796  272.       GO TO 219                                        CONC.329
4797  273.   215 IBF=3                                            12/22/81.346
4798  274.       NS=NN+1                                          CONC.331
4799  275.   219 NSS=NS-1                                         CONC.332
4800  276.       DO 218 N=1,NMAX                                  CONC.336
4801  277.       TMP5(N)=0.                                       CONC.337
4802  278.   218 TMP6(N)=0.                                       CONC.338
4803      C   FIND END OF LINE                                    CONC.339
4804  279.       DO 220 NZ=NS,NMAX                                CONC.340
4805  280.       NN=NZ                                            CONC.341
4806  281.       LI=IV2(NZ)                                       CONC.342
4807  282.       IF(LI.LT.1.OR.LI.GT.9) GO TO 351                 CONC.343
4808  283.       GO TO (221,221,391,224,221,220,220,223,225),LI   12/22/81.347
4809  284.   224 IQ=ICV(NN,M)-LI*10                               CONC.346
4810  285.       TMP5(NZ)=CB(IQ)                                  CONC.347
4811  286.       TMP6(NZ)=APAX1((SE(NN,M)+SE(NN+1,M))*.5-ZB(IQ),APSD)  CONC.348
4812  287.   220 CONTINUE                                         CONC.349
4813  288.       PRINT 6001,M,NS,ITIME                            CONC.350
4814  289. 6001  FORMAT(' M NS ITIME ',3I10)                      CONC.351
4815  290.       STOP                                             CONC.352
4816  291.   221 IBL=1                                            CONC.353
4817  292.       NE=NN                                            CONC.354
4818  293.       GO TO 229                                        CONC.355
4819  294.   223 IBL=2                                            12/22/81.348
4820  295.       NE=NN-1                                          CONC.357
4821  296.       GO TO 229                                        CONC.358
4822  297.       IBL=3                                            12/22/81.349
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   298.        NE=NN-1                                                     CCNC.360
   299.    225 NLL=NE+1                                                    CCNC.361
         C     SET BOUNDARY CONDITION AT BEGINNING                         CCNC.365
   300.        GO TO(240,242,242),IBF                                      CCNC.366
   301.    240 P(NSS)=C.                                                   CCNC.367
   302.        Q(NSS)=C.                                                   CCNC.368
   303.        R(NSS)=C.                                               12/22/81.350
   304.        S(NSS)=C.                                               12/22/81.351
   305.        GO TO 250                                                   CCNC.369
   306.    242 P(NSS)=0.                                                   CCNC.370
   307.        Q(NSS)=CNPL(NSS,M)                                      12/22/81.352
   308.        R(NSS)=C.                                               12/22/81.353
   309.        S(NSS)=CNPP(NSS,M)                                      12/22/81.354
   310.    250 DO 267 N=NSS,NE                                         12/22/81.355
   311.        D1(N)=CVMGN(TMP6(N),.5*(SEP(N+1,M)+SEP(N,M)-H(N,M)-H(N+1,M)),12/22/81.356
              1TMP6(N))                                                12/22/81.357
   312.        CBAR=CVMGN(TMP5(N),.5*(C(N+1,M)+C(N,M)),TMP5(N))        12/22/81.358
   313.    267 DK(N)=CY(N,M)*ABS(VP(N,M))+L1(N)/CEAM*CVMGZ(0.,DKYY(N,M),VP(N,M)) 12/22/81.359
   314.        DO 270 N=NS,NE                                              CCNC.384
   315.        DBAR1=.25*(SE(N,M)+SE(N,M+1)+SEP(N,M)+SEP(N,M+1))-.5*(H(N,M)+ CCNC.385
              1H(N,M+1))                                                   CCNC.386
   316.        T1=UP(N,M)+U(N,M)                                       12/22/81.360
   317.        DKX=CX(N,M)*ABS(T1)+DBAR1/(C(N,M)+C(N,M+1))             12/22/81.361
              1 +CVMGZ(0.,DKXX(N,M),T1)                                12/22/81.362
   318.        DBAR2=.25*(SE(N,M)+SE(N,M-1)+SEP(N,M)+SEP(N,M-1))-.5*(H(N,M) CCNC.389
              1+H(N,M-1))                                                  CCNC.390
   319.        T2=UP(N,M-1)+U(N,M-1)                                   12/22/81.363
   320.        DKXM=CX(N,M-1)*ABS(T2)+DBAR2/(C(N,M)+C(N,M-1))          12/22/81.364
              1 +CVMGZ(0.,DKXX(N,M-1),T2)                              12/22/81.365
   321.        TSYY=.5*TSY/YNL(2*N-1)                                      CCNC.395
   322.        TSYYM=1./(YNL(2*N-2)*DY)                                12/22/81.366
   323.        TSYYP=1./(YNL(2*N)*DY)                                  12/22/81.367
   324.        V1=AMAX1(0.,VP(N-1,M))                                  12/22/81.368
   325.        V2=AMIN1(0.,VP(N,M))                                    12/22/81.369
   326.        V3=AMIN1(0.,VP(N-1,M))                                  12/22/81.370
   327.        V4=AMAX1(0.,VP(N,M))                                    12/22/81.371
   328.        C1=2.*CVMGF(CPL(N,M),CPL(N,M+1),T1)                     12/22/81.372
   329.        C2=2.*CVMGF(CPL(N,M-1),CPL(N,M),T2)                     12/22/81.373
   330.        TP1=-TSYY*D1(N-1)                                       12/22/81.374
   331.        TP2=DK(N-1)*TSYYM                                       12/22/81.375
   332.        TP3=TSYY*D1(N)                                          12/22/81.376
   333.        TP4=DK(N)*TSYYP                                         12/22/81.377
   334.        TP5=SEP(N,M)-H(N,M)                                     12/22/81.378
   335.        TP6=.5*(SLP(N,M)+SE(N,M))-H(N,M)                        12/22/81.379
   336.        TP7=4.*DKX*TSXXP                                        12/22/81.380
   337.        TP8=4.*DKXM*TSXXM                                       12/22/81.381
   338.        AML(N)=TP1*(V1+TP2)                                     12/22/81.382
   339.        APL(N)=TP3*(V2-TP4)                                     12/22/81.383
   340.        AL(N)=TP5+TSYY*(D1(N)*(V4+TP4)-D1(N-1)*(V3-TP2))        12/22/81.384
   341.        PL(N)=TP6*CPL(N,M)-.25*TSXX*(DBAR1*(C1+T1-TP7*(CPL(N,M+1)- 12/22/81.385
              1 CPL(N,M)))-DBAR2*(C2*T2-TP8*(CPL(N,M)-CPL(N,M-1))))    12/22/81.386
   342.        V1=.5*VP(N-1,M)                                         12/22/81.387
   343.        V2=.5*VP(N,M)                                           12/22/81.388
   344.        C1=CPH(N,M)+CPH(N,M+1)                                  12/22/81.389
   345.        C2=CPH(N,M)+CPH(N,M-1)                                  12/22/81.390
   346.        APH(N)=TP1*(V1+TP2)                                     12/22/81.391
   347.        APH(N)=TP3*(V2-TP4)                                     12/22/81.392
   348.        AH(N)=TP5+TSYY*(D1(N)*(V2+TP4)-D1(N-1)*(V1-TP2))        12/22/81.393
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349. 260 BH(N)=TF6*CPH(N,M)-.25*TSXA*(DBAR1*(C1*T1-TF7*(CPH(N,M+1)-   12/22/81.394
         1 CPH(N,M)))-DBAR2*(C2*T2-TF8*(CPH(N,M)-CPH(N,M-1))))        12/22/81.395
350.     DO 2160 N=NS,NE                                               CONC.446
351.     C1=1./(AL(N)-APL(N)*P(N-1))                                   12/22/81.396
352.     P(N)=APL(N)*C1                                                12/22/81.397
353.     Q(N)=(BL(N)-APL(N)*Q(N-1))*C1                                 12/22/81.398
354.     C2=1./(AH(N)-APH(N)*R(N-1))                                   12/22/81.399
355.     R(N)=APH(N)*C2                                                CAL.494
356. 2160 S(N)=(BH(N)-APH(N)*S(N-1))*C2                                CAL.495
     C ..BOUNDARY CONDITIONS AT UPPER END                              CONC.453
357.     GO TO (270,280,260),IBL                                       12/22/81.402
358. 270 CNPH(NEL,M)=0.                                                12/22/81.403
359.     CNPL(NEL,M)=0.                                                12/22/81.404
360. 280 DO 281 J=NS,NE                                                12/22/81.405
361.     N=NE+NS-J                                                     12/22/81.406
362.     CNPL(N,M)=-P(N)*CNPL(N+1,M)+Q(N)                              12/22/81.407
363. 281 CNPH(N,M)=-R(N)*CNPH(N+1,M)+S(N)                              12/22/81.408
364.     NC=NEE                                                        12/22/81.409
365.     GO TO 286                                                     12/22/81.410
     C   COMPUTATIONAL LINE DEGENERATES TO A SINGLE CELL               CONC.459
366. 265 DBAR1=.25*(SEP(NN,M)+SEP(NN,M+1)+SE(NN,M)+SE(NN,M+1))-.5*(H(NN,M) 12/22/81.411
         1+H(NN,M+1))                                                  CONC.463
367.     T1=UP(NN,M)+U(NN,M)                                           12/22/81.412
368.     DPX=CX(NN,M)+ABS(T1)*DBAR1/(C(NN,M+1)+C(NN,M))                12/22/81.413
         1 +CVMGZ(0.,DKX)(NN,M),T1)                                    12/22/81.414
369.     DBAR2=.25*(SEP(NN,M)+SEP(NN,M-1)+SE(NN,M)+SE(NN,M-1))-.5*(H(NN,M)+ CONC.466
         1H(NN,M-1))                                                   CONC.467
370.     T2=UP(NN,M-1)+U(NN,M-1)                                       12/22/81.415
371.     DKXM=CX(NN,M-1)+ABS(T2)*DBAR2/(C(NN,M-1)+C(NN,M))             12/22/81.416
         1 +CVMGZ(0.,DKXX(NN,M-1),T2)                                  12/22/81.417
372.     TP5=1./(SEP(NN,M)-H(NN,M))                                    12/22/81.418
373.     TF6=.5*(SEP(NN,M)+SE(NN,M))-H(NN,M)                           12/22/81.419
374.     TP7=4.*DKX*TSXXP                                              12/22/81.420
375.     TP8=4.*DKXP*TSXXM                                             12/22/81.421
376.     C1=2.*CVMGP(CPL(NN,M),CPL(NN,M+1),T1)                         12/22/81.422
377.     C2=2.*CVMGP(CPL(NN,M-1),CPL(NN,M),T2)                         12/22/81.423
378.     CNPL(NN,M)=(TF6*CPL(NN,M)-.25*TSXX*(DBAR1*(C1*T1-TF7*         12/22/81.424
         1 (CPL(NN,M+1)-CPL(NN,M)))-DBAR2*(C2*T2-TF8*                  12/22/81.425
         2 (CPL(NN,M)-CPL(NN,M-1)))))*TF5                              12/22/81.426
379.     C1=CPH(NN,M+1)+CPH(NN,M)                                      12/22/81.427
380.     C2=CPH(NN,M)+CPH(NN,M-1)                                      12/22/81.428
381.     CNPH(NN,M)=(TF6*CPH(NN,M)-.25*TSXX*(DBAR1*(C1*T1-TP7*         12/22/81.429
         1 (CPH(NN,M+1)-CPH(NN,M)))-DBAR2*(C2*T2-TF8*                  12/22/81.430
         1 (CPH(NN,M)-CPH(NN,M-1)))))*TF5                              12/22/81.431
382.     NC=NN+1                                                       12/22/81.432
383. 286 IF(NC.LT.MAX) GO TO 35                                        CONC.515
384. 88  CONTINUE                                                      CONC.516
385.     IF(ITIPL.GE.IDEBUG)CALL DEBUG(1)                              CAL.496
386.     DO 1 M=1,M1                                                   CAL.497
387.     DO 1 N=1,N1                                                   CAL.498
388.     IF(C(N,M))1,1,2                                               FCT.28
389. 2   DP1=.5*(SEP(N,M)+SE(N,M))-H(N,M)                              FCT.29
390.     DP2=.5*(SEP(N+1,M)+SE(N+1,M))-H(N+1,M)                        FCT.30
391.     VEL=(VP(N,M)+V(N,M))/2.                                       FCT.31
392.     V1=VEL*TAU*XPL(.*M-1)*DX                                      FCT.32
393.     C1=(CNPH(N+1,M)+CN(N+1,M)+CNPH(N,M)+CN(N,M))*.25              FCT.33
         1 -CVMGP((CNPL(N,M)+CN(N,M))/2.,(CNPL(N+1,M)+CN(N+1,M))/2.,VEL) FCT.34
394.     FLUY(N,M)=V1*(DP1+DP2)*C1*.5                                  FCT.35
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      DISP=CY(N,P)+ABS(VEL)+(DF1+DF2)/(C(N+1,P)+C(N,P))                 FCT.36
     1 +CVMGZ(0.,DKY(N,P),VEL)                                          FCT.37
      FLUY(N,P)=FLUY(N,M)-TAU*XML(2*P-1)*CX*DISP*(DP1+DP2)*             FCT.38
     1 (CNPM(N+1,M)+CNPL(N,M)-CAPP(N,P)-CAPL(N+1,M))/(4.*YNC(2*N)*DY)   FCT.39
      DP2=.5*(SEP(N,M+1)+SE(N,P+1))-F(N,P+1)                            FCT.40
      VEL=(UF(N,P)+UF(N,M))/2.                                          FCT.41
      V1=VEL*TAU*YFL(2*N-1)*DY                                          FCT.42
      C1=(CNPP(N,P+1)+CN(N,P+1)+CPPP(N,P)+CN(N,P))*.25                  FCT.43
     1 -CVMGP((CPFL(N,M)+CN(N,P))/2.,(CNPL(N,P+1)+CN(N,P+1))/2.,VEL)    FCT.44
      FLUX(N,P)=V1*(DP1+DP2)*C1*.5                                      FCT.45
      DISP=CX(N,M)*ABS(VEL)*(DF1+DF2)/(C(N,P+1)+C(N,P))                 FCT.46
     1 +CVMGZ(0.,DKX(N,P),VEL)                                          FCT.47
      FLUX(N,P)=FLUX(N,P)-TAU*YRL(2*N-1)*DY*DISP*(DP1+DP2)*             FCT.48
     1 (CNPH(N,P+1)+CPPL(N,P)-CAPP(N,P)-CPPL(N,P+1))/(4.*XML(2*M)*DX)   FCT.49
    1 CONTINUE                                                          FCT.71
C     SET ANTI-DIFFUSIVE FLUXES TC ZERC CN BOUNDARIES               12/22/81.433
      NB(1)=KLV                                                     12/22/81.434
      NB(2)=KTT                                                     12/22/81.435
      DO 40 J=1,2                                                   12/22/81.436
      IF(NB(J))40,40,41                                             12/22/81.437
   41 DO 3 I=1,NB(J)                                                12/22/81.438
      IF(J-1)15,16,15                                               12/22/81.439
   16 IP=IFLOW(I)                                                   12/22/81.440
      GO TO 17                                                      12/22/81.441
   15 IP=ITTDE(I)                                                   12/22/81.442
   17 INDX=IP/1000000                                               12/22/81.443
      IP=IP-1000000*INDX                                            12/22/81.444
      N=IP/1000                                                     12/22/81.445
      M=IP-1000*N                                                   12/22/81.446
      I4=INDX/100                                                   12/22/81.447
      IF=INDX-100*I4                                                12/22/81.448
      IDIR=IF/10                                                    12/22/81.449
      IF(IDIR-1)4,55,4                                              12/22/81.450
   55 FLUX(N,P-I4)=0.                                               12/22/81.451
      GC TO 3                                                       12/22/81.452
    4 FLUY(N-I4,P)=0.                                               12/22/81.453
    3 CONTINUE                                                      12/22/81.454
   40 CONTINUE                                                      12/22/81.455
C     COMPUTE UPDATED FLUX CORRECTED SOLUTION                           FCT.72
      DO 5 M=2,M1                                                       CAL.499
      DO 5 N=2,N1                                                       CAL.500
      RM(N,M)=0.                                                        CAL.501
      RP(N,M)=0.                                                        CAL.502
      IF(C(N,M))5,5,12                                                  CAL.503
   12 IF(ICU(N,M)/10.EQ.7)GO TO 5                                       CAL.504
      IF(ICV(N,M)/10.EQ.7)GO TO 5                                       CAL.505
      C0=CN(N,M)                                                        CAL.506
      ML1=M-1                                                           CAL.507
      MU1=M+1                                                           CAL.508
      NU1=N+1                                                           CAL.509
      NL1=N-1                                                           CAL.510
      C1=CVMGT( CN(N,M), CN(N,ML1),C(N,ML1).LE.0..OR.ICU(N,ML1)/10.EQ.  CAL.511
     1 1)                                                               CAL.512
      C2=CVMGT( CN(N,M), CN(N,MU1),C(N,MU1).LE.0..OR.ICU(N,M)/10.EQ.1)  CAL.513
      C3=CVMGT( CN(N,M), CN(NL1,M),C(NL1,M).LE.0..OR.ICV(NL1,M)/10.EQ.  CAL.514
     1 1)                                                               CAL.515
      C4=CVMGT( CN(N,M), CN(NU1,M),C(NU1,M).LE.0..OR.ICV(N,M)/10.EQ.1)  CAL.516
      UMA =AMAX1(C0,C1,C2,C3,C4)                                        CAL.517
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 4997    444.       MI =AMIN1(C0,C1,C2,C3,C4)                                          CAL.518
 4998    445.       C0=CNPL(N,M)                                                       CAL.519
 4999    446.       C1=CVMGT(CNPL(N,M),CNPL(N,ML1),C(N,ML1).LE.0..OR.ICU(N,ML1)/10.EQ.   CAL.520
 5000              1 1)                                                                 CAL.521
 5001    447.       C2=CVMGT(CNPL(N,M),CNPL(N,MU1),C(N,MU1).LE.0..OR.ICU(N,M)/10.EQ.1)   CAL.522
 5002    448.       C3=CVMGT(CNPL(N,M),CNPL(NL1,M),C(NL1,M).LE.0..OR.ICV(NL1,M)/10.EQ.   CAL.523
 5003              1 1)                                                                 CAL.524
 5004    449.       C4=CVMGT(CNPL(N,M),CNPL(NU1,M),C(NU1,M).LE.0..OR.ICV(N,M)/10.EQ.1)   CAL.525
 5005    450.       WMAX=AMAX1(C0,C1,C2,C3,C4,WMA)                                     CAL.526
 5006    451.       WMIN=AMIN1(C0,C1,C2,C3,C4,WMI)                                     CAL.527
 5007    452.       VOL=DX*DY*YPU(2*M-1)*YNU(2*N-1)*(SEP(N,M)-F(N,M))                  FCT.97
 5008    453.       PF=AMAX1(0.,FLLY(N,M-1))-AMIN1(0.,FLLX(N,M))                       12/22/81.456
 5009              1  +AMAX1(0.,FLLY(N-1,M))-AMIN1(0.,FLLY(N,M))                       FCT.99
 5010    454.       IF(PF)6,6,7                                                        CAL.528
 5011    455.  7    QQ=(WMAX-C0)*VOL                                                   CAL.529
 5012    456.       RP(N,M)=AMIN1(1.,QQ/PP)                                            CAL.530
 5013    457.  6    PF=AMAX1(0.,FLUX(N,M))-AMIN1(0.,FLUX(N,M-1))                       CAL.531
 5014              1  +AMAX1(0.,FLUY(N,M))-AMIN1(0.,FLUY(N-1,M))                       FCT.106
 5015    458.       IF(PF)5,5,8                                                        CAL.532
 5016    459.  8    QQ=(C0-WMIN)*VOL                                                   CAL.533
 5017    460.       RN(N,M)=AMIN1(1.,QQ/PP)                                            CAL.534
 5018    461.  5    CONTINUE                                                           CAL.535
 5019    462.       DO 10 M=2,M1                                                       CAL.536
 5020    463.       DO 10 N=2,N1                                                       CAL.537
 5021    464.       IF(C(N,M))10,10,13                                                 CAL.538
 5022    465.  13   IF(ICU(N,M)/10.EQ.7)GO TO 10                                       CAL.539
 5023    466.       IF(ICV(N,M)/10.EQ.7)GO TO 10                                       CAL.540
 5024    467.       CXU=CVMGP(AMIN1(RP(N,M+1),RN(N,M)),AMIN1(RN(N,M+1),RP(N,M)),       CAL.541
 5025              1  FLUX(N,M))                                                       CAL.542
 5026    468.       CXL=CVMGP(AMIN1(RP(N,M),RN(N,M-1)),AMIN1(RN(N,M),RP(N,M-1)),       CAL.543
 5027              1  FLUX(N,M-1))                                                     CAL.544
 5028    469.       CYU=CVMGP(AMIN1(RP(N+1,M),RN(N,M)),AMIN1(RN(N+1,M),RP(N,M)),       CAL.545
 5029              1  FLUY(N,M))                                                       CAL.546
 5030    470.       CYL=CVMGP(AMIN1(RP(N,M),RN(N-1,M)),AMIN1(RN(N,M),RP(N-1,M)),       CAL.547
 5031              1  FLUY(N-1,M))                                                     CAL.548
 5032    471.       DENOM=DX*DY*XPL(2*M-1)*YRL(2*N-1)*(SEP(N,M)-F(N,M))                FCT.118
 5033    472.       CNPN(N,M)=CNPL(N,M)-(CXU*FLUX(N,M)-CXL*FLUX(N,M-1)                 FCT.121
 5034              1  +CYU*FLUY(N,M)-CYL*FLUY(N-1,M))/DENOM                            FCT.122
 5035    473.  10   CONTINUE                                                           CAL.549
 5036    474.       IF(ITIME.GE.IDEBUG)CALL DEBUG(2)                                   CAL.550
 5037    475.       RETURN                                                             FCT.126
 5038    476.  351  PRINT 352,L1,ITIME,MM,NN,M,N                                      12/22/81.463
 5039    477.  352  FORMAT(5X,*FLAG ARRAY PROBLEM*,/,10X,6I10/1H1)                   12/22/81.464
 5040    478.       CALL PRCHIC(C,NMAX,MMAX,2,1,)                                      12/22/81.465
 5041    479.       STOP                                                               12/22/81.466
 5042    480.       END                                                                FCT.127
CONC            VECTOR LOOP BEGINS AT SEQ. NO.     61, P=     426D
CONC            VECTOR LOOP BEGINS AT SEQ. NO.     64, P=     457C

  AT SEQUENCE NUMBER -     9?.
PRNAME CONC      COMMENT -   DEPENDENCY INVOLVING ARRAY RCPLB IN SEQUENCE NUMBER 100 ********************************* PR00100270
CONC            VECTOR LOOP BEGINS AT SEQ. NO.    103, P=     601C
CONC            VECTOR LOOP BEGINS AT SEQ. NO.    110, P=     626D
CONC            VECTOR LOOP BEGINS AT SEQ. NO.    113, P=     654A
CONC            VECTOR LOOP BEGINS AT SEQ. NO.    135, P=     744A
CONC            VECTOR LOOP BEGINS AT SEQ. NO.    165, P=    1060B
CONC            VECTOR LOOP BEGINS AT SEQ. NO.    175, P=    1131D
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 1.    SUBROUTINE CCFCL                                                     CAL.551
 2.    PARAMETER (NUPFI=1372,NCIP=45,PLIP=22,NFPTS=1)                         CAL.5
 3.    PARAMETER (IFRC=605,IDXS=20,IFUT=1,ITCS=40,JPUT=7205,JFLS=2)           CAL.6
 4.    LOGICAL ITAFE,IPT,IDUMP                                             SCALAR.2
 5.    COMMON /V1/ NPAX,MPAX,NTIC,NFLC,ITIC,JTIC,INITL,NP1,NP2,NP3,NPR,    SCALAR.3
      1 MPR,MAXTIP,NTAP,ICELAY,IFLCT,NCALF,N1,M1,NX1,MAI,ISTEP,KK,        SCALAR.4
      2 ITAPE,IP1,IPP,NFREG,IRECN,IXLAN,NPX,PSURF,NXX,NYY,NZP,NDTAP,      SCALAR.5
      3 JPO,NREST,KS1,KS2,KS3,KS4,KS5,KS6,NNPCT,PSKP,MDLY,ITAPE,IPT,      2/2/81.1
      4 IDUMP,INC,KBT,KFT,KTT,ITYP,INDX,ICIR,KUV,KTRANS,NBG,MBG,KSB        SCALAR.7
      5 ,IRESTR,NCCAT,IGVER,IFLVL,KL,INFT,NSTP,NTSW,NWAT,KAC,PLIM         SCALAR.8
      6 ,NS2,MS2,LEVEL,NDX,NZ0,ACCWAT,IVPLCT,ICPLCT,IPOT,ISLRE,NTABLE,    SCALAR.9
      7 IFCPD,ACHAN,MCG,ITRM,IELCF,NCF,NDAX                               SCALAR.10
      8 ,NCON                                                            12/22/81.1
 6.    COMMON /V2/ TAL,LT,DX,DY,DX2,DY2,G,G2,ALAT,X1,WA,THETA,CFSD,       SCALAR.11
      1 EPSD2,EPSD3,EPSD4,EPSDE,CCCKI,FCTA,SIXTH,PI,PIIEO,TSX,TSY,       SCALAR.12
      2 ADV,VIS,DMPX,CMAXG,SINIT,APSD,TPRC,TPE,                           SCALAR.13
      3 YLAND,XSCCUN,SMAX,TZ1,TAUX,TAUY,FF,DXP,DYP,ZN1,ZN2                SCALAR.14
      4 ,XU,YU,XU1,YU1,DCCN2,WATERN,DLIMIT                                SCALAR.15
      5 ,GTSX,CTSY,CCT,CCT2,FF2,CCCX,CCCY,C2T,CT,X12                      SCALAR.16
      6 ,FXS,FYS,FATPS,TSPL,ICALS,ISALC,CMAX,XMS,IFETR                       CAL.1
 7.    COMMON /AA1/ SEP(NUMPT),SE(NUMPT),SEP(NUMPT)                       EUVHCID.2
 8.    COMMON /AA2/ UP(NUMPT),U(NUMPT),UM(NUMPT),F(NUMPT)                 EUVHCID.3
 9.    COMMON /AA3/ VP(NUMPT),V(NUMPT),VM(NUMPT),C(NUMPT)                 EUVHCID.4
10.    COMMON /AA7/ FRIC(IFRC,IDXS),SURFF(IFLT,ITCS),DCHNGE(JFLT,JFLS)      ARRAY.2
      2 ,CCNE(IPLT,ITLS),CUND(JFLT,JFLS)                                   TEST.1
11.    COMMON /AA5/ ICU(NUMPT),ICV(NUMPT),JSB(NUMPT)                     ARRAYID.2
12.    COMMON /AA6/ FXX(NUMPT),FYY(NUMPT),FPEC(NUMPT),ISYCRE(NUMPT)      ARRAYID.3
13.    COMMON/V15/GL1(500),GL2(500),CL3(500),CL4(500),GL5(500)              MISC.2
14.    COMMON/V8/ NV(150),XMU(300),YAL(300),IIBAY(20),NBAY(20),R1(20),     MISC.3
      1        R2(20),AS(20),ACL(20)                                        MISC.4
      1 ,XPUT(300),YRLT(300)                                                MISC.5
15.    COMMON /V5/ A(150),B(150),F(150),G(150),H(150),S(150),ISP(150)      MISC.6
      1 ,DI(150),FX(150),FY(150),PATP(150),VISC(150),ADVE(150),ADVC(150)   MISC.7
16.    COMMON /V10/ IL1(150),IU2(150),IV1(150),IV2(150)                     MISC.8
      1 ,NGBD(300),NGLOB,TME1,TME2,TME3,TME4                                 CAL.3
17.    COMMON /V11/ TPOC(150),TCCN(50),LDX(50),KDX(50)                     MISC.10
      1 ,WAT(50),TPT(50),NCARD(50)                                         MISC.11
18.    INTEGER CCAST                                                       MISC.12
19.    COMMON /AAE/ SGRIC(1,1),TGRIC(1,1),CCAST(1),SURPLT(1,1)            MISC.13
20.    COMMON/CALC/TMP1(150),TMP2(150),TMP3(150),TMP4(150),TMP5(150),      TEST.4
      1 TMP6(150)                                                          TEST.5
21.    DIMENSION AL(150),BL(150),AFL(150),APL(150),DK(150)                  CAL.4
      1 ,UT(150)                                                        12/22/81.6
22.    EQUIVALENCE (AL(1),A(1)),(BL(1),B(1)),(AFL(1),VISC(1)),           12/22/81.7
      1 (AML(1),ADVB(1)),(DK(1),ADVC(1)),(UT(1),FX(1))                 12/22/81.8
23.    DIMENSION AMH(150),APH(150),AH(150),BH(150)                       12/22/81.9
24.    EQUIVALENCE (APH(1),TMP1(1)),(AMH(1),TMP2(1)),(AH(1),TMP3(1)),    12/22/81.10
      1 (BH(1),TMP4(1))                                                12/22/81.11
25.    COMMON/CMASS/ND(2),SUMB(2),SLPTB                                  12/22/81.12
26.    COMMON/V6/ IBARX(200),IBARY(200),IBART(200),IBARK(200,5),          FLCDRY.2
      1 ITIDE(200),IFLOW(60),ITRANS(20),ICFAN(10),XCHAN(200,2)           FLODRY.3
      1 ,INT(200),F1(200),ITG1(200),ITG2(200)                            12/22/81.4
27.    COMMON /V7/ XPAK(20),ZB(20),CB(20),CC(20),CAYD(20),CD(20)          FLCDRY.4
      * ,CANPY1(20),CANPY2(20)                                            FLCDRY.5
28.    COMMON /AA4/ IFLOOD(NFPTS),ZFU(NFPTS),ZFV(NFPTS),CHZ(NFPTS),       FLODRY.6
      1 IFAS(NFPTS)                                                       FLODRY.7
29.    DIMENSION JFLCD(NFPTS)                                             FLODRY.8
30.    EQUIVALENCE (JFLOD(1),CHZ(1))                                      FLODRY.9
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31.        COMMON/EMASSE/SLMBL(2,2),SLPTEE(2),ITERP                          CAL.559
32.        COMMON/CONC/CN(NUMPT),CNP(NUMPT),CNPL(NUMPT),                     CAL.560
          1CPH(NUMPT),CNP(NUMPT),CX(NUMPT),CY(NUMPT),                         CAL.561
          2DKXX(NUMPT),DKYY(NUMPT),FLUX(NUMPT),FLUY(NUMPT),                   CAL.562
          3RP(NUMPT),PP(NUMPT)                                                CAL.563
33.        COMMON/LOPT/IECEUG,ALL,ALG,PLL,PLU                                CAL.564
      C STATEMENT FUNCTION DEFINITION                                         CAL.565
34.        DF(DIF1,DIF2,VLL,DEPTH,CHEZY)=DIF1+ABS(VEL)*DEPTH/CHEZY           CAL.566
          1*CVMGZ(G.,DIF2,VEL)                                                CAL.567
35.        SBAR(S1,S2)=.5*(S1+S2)                                            CAL.568
      C DETERMINE BOUNDARY CONDITIONS                                         CAL.569
      C                                                                       CAL.570
      C FLOW BOUNDARY CONCENTRATIONS                                          CAL.571
      C                                                                       CAL.572
36.        MM=MAX0(KK-1,1)                                                   CAL.573
37.        MM1=MAX0(MP-1,1)                                                  CAL.574
38.        DO 60 I=1,KUV                                                     CAL.575
39.        IP=IFLOW(I)                                                       CAL.576
40.        INDX=IP/1000000                                                   CAL.577
41.        IP=IP-1000000*INDX                                                CAL.578
42.        N=IP/1000                                                         CAL.579
43.        M=IP-1000*N                                                       CAL.580
44.        INDX=INDX-INDX/100*100                                            CAL.581
45.        IDIR=INDX/10                                                      CAL.582
46.        INDX=INDX-10*IDIR                                                 CAL.583
47.        LL=(M-1)*NPPX+N                                                   CAL.584
48.        CNP(LL)=CONC(KK,INDX)                                             CAL.585
49.        IF(KK-1.NE.ISALC)GO TO 60                                         CAL.586
50.        CNM(LL)=CONC(MP1,INDX)                                            CAL.587
51.        CN(LL)=CONC(PP,INDX)                                              CAL.588
52. 60     CONTINUE                                                          CAL.589
      C ELEVATION BOUNDARY CONCENTRATIONS                                     CAL.590
53.        IF(NGLOB.EQ.0)GO TO 105                                           CAL.591
54.        IF(TME-TME4)102,102,103                                           CAL.592
55. 103    TME3=TME4                                                         CAL.593
56.        DO 104 I=1,NGLCB                                                  CAL.594
57. 104    GL4(I)=GL5(I)                                                     CAL.595
58.        READ(34)TME4,(GL5(I),I=1,NGLCB)                                   CAL.596
59. 102    DO 108 I=1,NGLCB                                                  CAL.597
60. 108    GL3(I)=GL4(I)+(TME-TME3)*(GL5(I)-GL4(I))/(TME4-TME3)              CAL.598
61.        IF(IPT)PRINT 5005,TME3,(GL4(I),I=1,NGLCB)                         CAL.599
62.        IF(IPT)PRINT 5005,TME4,(GL5(I),I=1,NGLCB)                         CAL.600
63. 5005   FORMAT(*   TIME (HC) *,F8.2,1X,*GLOBAL GRID SALINITY LEVELS*,/,   CAL.601
          1  (5X,10(F6.2,5X),/))                                              CAL.602
64.        IF(IPT)PRINT 5000,TME,(GL3(I),I=1,NGLCB)                          CAL.603
65. 5000   FORMAT(*   TIME *,F8.2,1X,*TIME INTR. GLOBAL GRID SALINTY*,/,     CAL.604
          1  (5X,10(F6.2,5X),/))                                              CAL.605
66. 105    DO 50 I=1,KTT                                                     CAL.606
67.        IP=ITIDE(I)                                                       CAL.607
68.        INDX=IP/1000000                                                   CAL.608
69.        IP=IP-1000000*INDX                                                CAL.609
70.        N=IP/1000                                                         CAL.610
71.        M=IP-1000*N                                                       CAL.611
72.        LL=(M-1)*NPPX+N                                                   CAL.612
73.        IF(INT(I)) 6005,6006,6005                                         CAL.613
74. 6005   IF(NGLOB.GT.0)GO TO 106                                           CAL.614
75.        CNP(LL)=(1.-FI(I))*CONC(KK,ITG1(I))+FI(I)*CONC(KK,ITG2(I))        CAL.615
76.        IF(KK-1.NE.ISALC)GO TO 50                                         CAL.616
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5159   77.        CMP(LL)=(1.-FI(I))*CONE(PP1,ITC1(I))+FI(I)*CCNE(MM1,ITG2(I))     CAL.617
5160   78.        CN(LL)=(1.-FI(I))*CONE(PP,ITC1(I))+FI(I)*CCNE(PM,ITG2(I))        CAL.618
5161   79.        GO TO 50                                                         CAL.619
5162   80.  106   CNP(LL)=(1.-FI(I))*GL3(ITG1(I))+FI(I)*GL3(ITG2(I))               CAL.620
5163   81.        GO TO 50                                                         CAL.621
5164   82.  FOCE  INDX=INCX-INDY/100*100                                           CAL.622
5165   83.        IDIR=INCX/10                                                     CAL.623
5166   84.        INDX=INCX-10*IDIR                                                CAL.624
5167   85.        CNP(LL)=CONE(KK,INDX)                                            CAL.625
5168   86.        IF(KK-1.NE.ISALC)GO TO 50                                        CAL.626
5169   87.        CNM(LL)=CONE(PP1,INDX)                                           CAL.627
5170   88.        CN(LL)=CONE(PP,INDX)                                             CAL.628
5171   89.  50    CONTINUE                                                         CAL.629
5172       C COMPUTE FLUXES                                                        CAL.630
5173   90.        DO 1 M=1,M1                                                      CAL.631
5174   91.        IT=(M-1)*NPAX                                                    CAL.632
5175   92.        CY1=TAU*XML(2*P-1)*DX                                            CAL.633
5176   93.        CY2=2.*CY1/CY                                                    CAL.634
5177   94.        DO 1 N=1,N1                                                      CAL.635
5178   95.        I=IT+N                                                           CAL.636
5179   96.        IF(C(I)) 1,1,2                                                   CAL.637
5180   97.  2     IPM=I+NPAX                                                       CAL.638
5181   98.        IPN=I+1                                                          CAL.639
5182   99.        CA1=TAU*YNL(2*N-1)*CY                                            CAL.640
5183   100.       CX2=2.*CX1/CX                                                    CAL.641
5184   101.       DPARX=SLAR(SEP(I)-F(I),SEP(IPP)-F(IPP))                          CAL.642
5185   102.       FLUX(I)=CX1*(UF(I)+UM(I))*SBAR(SE(I)-F(I),SE(IPM)-M(IPM))*       CAL.643
5186             1SBAR(CN(I),CN(IPM))-CX2*DBARX*DF(CX(I),DKXX(I),                  CAL.644
5187             2UM(I),DEARX,SBAR(C(I),C(IPM)))*(CNP(IPM)-CNP(I))/XMU(2*N)        CAL.645
5188   103.       DEARY=SEAR(SEP(I)-F(I),SEP(IPN)-F(IPN))                          CAL.646
5189   104.       FLUY(I)=CY1*(VF(I)+VM(I))*SEAR(SE(I)-F(I),SE(IPN)-F(IPN))        CAL.647
5190             1*SBAR(CN(I),CN(IPN))-CY2*DEARY*DF(CY(I),DKYY(I),                 CAL.648
5191             2VM(I),DEARY,SBAR(C(I),C(IPN)))*(CNP(IPN)-CNM(I))/YNU(2*N)        CAL.649
5192   105.  1    CONTINUE                                                         CAL.650
5193       C COMPUTE UPDATED SOLUTION                                              CAL.651
5194   106.       DO 5 M=2,M1                                                      CAL.652
5195   107.       IT=(M-1)*NPAX                                                    CAL.653
5196   108.       CA1=XMU(2*P-1)*DX                                                CAL.654
5197   109.       DO 5 N=2,N1                                                      CAL.655
5198   110.       I=IT+N                                                           CAL.656
5199   111.       IF(C(I)) 5,5,6                                                   CAL.657
5200   112.  6    IF(ICU(I)/10.EQ.7) GO TO 5                                       CAL.658
5201   113.       IF(ICV(I)/10.EQ.7) GO TO 5                                       CAL.659
5202   114.       IPM=I-NPAX                                                       CAL.660
5203   115.       IMN=I-1                                                          CAL.661
5204   116.       VOL=CX1*YNL(2*N-1)*DY*(SEP(I)-F(I))                              CAL.662
5205   117.       CX2=(SEM(I)-M(I))/(SEP(I)-F(I))                                  CAL.663
5206   118.       CNP(I)=CX2*CNP(I)-(FLUX(I)-FLUX(IPP)+FLUY(I)-FLUY(IPN))/VOL      CAL.664
5207   119.  5    CONTINUE                                                         CAL.665
5208       C UPDATE BOUNDARY FLUX MASS ACCOUNTING                                  CAL.666
5209   120.       ITERM=1                                                          CAL.667
5210   121.       IF(MOD(ITIPE,2).EQ.0) ITERP=2                                    CAL.668
5211   122.       NB(1)=KLV                                                        CAL.669
5212   123.       NB(2)=KIT                                                        CAL.670
5213   124.       SUMTPE(ITERP)=0.                                                 CAL.671
5214   125.       DO 40 J=1,2                                                      CAL.672
5215   126.       IF(NB(J)) 40,40,41                                               CAL.673
5216   127.  41   DO 3 I=1,NB(J)                                                   CAL.674
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CCNCE     PAGE 4              CA=AELPPGNSV2              06/20/83  FX=V  09:11:41      CFT 104F(04/14/83)  PAGE 16

 5217   128.        IF(J-1) 15,16,15                                                 CAL.675
 5218   129.     16 IF=IFLOW(I)                                                      CAL.676
 5219   130.        GO TO 17                                                         CAL.677
 5220   131.     15 IP=ITIDE(I)                                                      CAL.678
 5221   132.     17 INDX=IP/1000000                                                  CAL.679
 5222   133.        IP=IP-1000000*INDX                                               CAL.680
 5223   134.        NN=IP/1000                                                       CAL.681
 5224   135.        MP=IP-1000*NN                                                    CAL.682
 5225   136.        I4=INDX/100                                                      CAL.683
 5226   137.        IP=CVMGZ(1,-I4,I4)                                               CAL.684
 5227   138.        SIGN=FLOAT(IP)                                                   CAL.685
 5228   139.        IP=INDX-100*I4                                                   CAL.686
 5229   140.        IDIR=IP/10                                                       CAL.687
 5230   141.        IF(IDIR-1)94,95,94                                               CAL.688
 5231   142. 95     N=NN                                                             CAL.689
 5232   143.        M=MM-I4                                                          CAL.690
 5233   144.        LL=(M-1)*NPAX+N                                                  CAL.691
 5234   145.        SUMBE(J,ITERM)=SUMBE(J,ITERM)+SIGN*FLUX(LL)                      CAL.692
 5235   146.        GO TO 3                                                          CAL.693
 5236   147. 94     N=NN-I4                                                          CAL.694
 5237   148.        M=MM                                                             CAL.695
 5238   149.        LL=(M-1)*NPAX+N                                                  CAL.696
 5239   150.        SUMBE(J,ITERM)=SUMBE(J,ITERM)+SIGN*FLUY(LL)                      CAL.697
 5240   151.      3 CONTINUE                                                         CAL.698
 5241   152.     40 SUMTBE(ITERM)=SUMTBE(ITERM)+SUMBE(J,ITERM)                       CAL.699
 5242          C TEST FOR CALL TO FLDUG SUBROUTINE                                   CAL.700
 5243   153.        IF(ITIME.GE.IDEBUG)CALL DEBUE                                    CAL.701
 5244   154.        RETURN                                                           CAL.702
 5245   155.        END                                                              CAL.703
CCNCE          VECTOR LOOP BEGINS AT SEQ. NO.     56, F=     167C
CCNCE          VECTOR LOOP BEGINS AT SEQ. NO.     55, F=     220F
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APPENDIX B: WIFM-SAL INPUT REQUIREMENTS

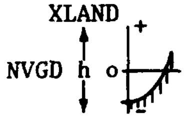
Card Group (Format)		Variable	Description
1 (16I5)	Required	NDTAP	Input tape unit
1a (8A8)	Required	ITL	Identification title card, up to 64 character, the 1st 8 are the plot identification
2 (16I5)	Required	NMAX	Horizontal grid dimension (i.e., number of cells in the n-direction)
		MMAX	Vertical grid dimension, number of cells in the m-direction
Restart conditions: system geometry and boundary imput tables ARE NOT read in hot start conditions: INITL = 0 system geometry and boundary input MUST be read in; η , u , and v are all that has been saved		INITL	0--initial condition 1--restart conditions (omit card groups 6, 13-18, and 23) -m--as for 0, but saves restart data every m tau
		IOVER	Control variable 1--simulation 0--reads input only
		IFLVL	0--flow formulation 1--velocity
		LEVEL	Number of time levels
		ISURG	0--tidal circulation 1--storm surge-horizontal coastline 2--storm surge-vertical coastline
		IFETR	0--no feathering of tidal elevation, boundary elevations, and freshwater discharges 1--feathering of the above quantities
		IHOT	0--normal run -1--hot start information previously saved for η,u,v initial conditions on logical unit 2 will be used n--save hot start conditions at itime = n on logical unit 21 Note η is surface elevation u is x-component of velocity v is y-component of velocity itime is the number of time steps elapsed

Card Group (Format)		Variable	Description
2a (3I5,2F10.0)	Required	ISAL	1--salinity simulation 0--not simulating salinity
Use a blank card for this group when you are not simulating salinity		ISALS ISALC	1--FCT scheme 2--3 Time Level Explicit Scheme number of time steps into the simulation, when salinity starts
		CMAX	Maximum salinity concentration allowable, in ppt. If CMAX is exceeded, error message is output
		XMS	Scale factor by which salinity concentrations are multiplied for printout (dimensionless)
3 (16I5)	Required	ITID	Number of entries in tidal input table or flow input table
		JTID	Number of τ's between entries in the tidal or flow input tables. Note: if tidal constituents are used, set ITID equal to the number of τ's in the tidal scenerio. Set ITJD = 1 . Cannot mix constituent or tabular entries.
		NTID	Number of distinct tidal inputs (total number)
		NFLO	Number of distinct discharge input (total number)
	Pertains only to velocity grid	NP1 NP2 NP3	These are print controls for the output grid--grid is printed from N = NP1 to N = NP2 in steps of NP3 NP1 and NP2 are horizontal indices All vertical values for each N NP3 is the increment
		NPR	Overrides NP1,NP2,NP3 2--print full grid of η only -2--print full grid for η,u,v 1--print from NP1 to NP2, η only -1--print from NP1 to NP2, η,u,v
		MPR	Additional print control 1--print flag arrays only -1--print flag arrays, flood, barrier, and tidal or flow data 2--print flag arrays, depths, and Chezy -2--print all
		MSURF	Counter Prints surface elevation and discharge in increments of the values of MSURF

Card Group (Format)		Variable	Description
3 (16I5) (Continued)			
			KS1,KS2,KS3,KS4 are flooding control
		KS1	m--hold cell face CLOSED for mτ's
		KS2	m--hold cell face OPEN for mτ's
		KS3	m--hold SUBMERGED barrier characteristic for mτ's
		KS4	m--hold OVERTOPPING BARRIER characteristic for mτ's
		KS5	Leave blank, not used at present
		KS6	m--updates wind routine every mτ's
3a (16I5)	Required	NCON	Number of tide gages for which tidal constituents must be specified
		NGLOB	Number of global grid tidal boundary signals used for cell-centered interpolation along the refined grid boundary
		NTI	Number of tidal boundary signals used for cell-centered interpolation along the seaward boundary
3b (16I5)	Optional	IGX_i	Location expressed in m (grid coordinate) for each tidal signal, i = 1,NT
NT = NTI + NGLOB Omit if NT = ϕ		IGY_i	Location expressed in m (grid coordinate) for each tidal signal, -i = 1,NT
3c Use only if NCON.GT.ϕ		IYEAR	Start time of simulation
		IMONTH	Start time of simulation
Omit if NCON.EQ.ϕ		IDAY	Start time of simulation
		IHR	Start time of simulation
3d (37I1) Omit if NCON.EQ.ϕ		ICONST	Refers to array NCONST which contains 37 constituents. To choose how many constituents you wish to consider, code this variable 1--consider 0--skip
3e (16I5) Omit if NCON.EQ.ϕ		NC_j	j varies from 1 to NCONT where NCONT is the element number of the specific constituent you want considered from array NCONST

Card Group (Format)	Variable	Description
4 (8F10.0) Required Note: See IXPAN in card group 5. Code DX and DY. 1 map inch = X number of feet when card group 6 will be utilized Example: Map scale 1:40000 CX = 3333.	TAU	Time step length, i.e. Δt (sec)
	*DX	Vertical spatial stepsize (minimum stepsize for α space) from map scale use 1 in. = ____ ft
	*DY	Horizontal spatial stepsize (ft) 1 in. = ____ ft
	G	Acceleration of gravity set to 32.2 (ft^2/sec)
	ALAT	Average latitude of the study region, + for Northern hemisphere (·) - for Southern hemisphere
	XI	Constant rate of rainfall (inches/ day)
	WA	Constant wind velocity (no N/S wind) -1--variable wind as a function of time only. (Note: card group 11 is needed to complete wind information) -2--variable wind as a function of space and time. (Provided by subroutine FETCHW.) (Note: omit card group 11)
	THETA	Constant wind direction in degrees Use meteorological definition, i.e. NORTH is 0° EAST is 90° SOUTH is 180° WEST is 270° or the number of hours between entries of wind table if WA = -1
	EPSD	ε_d is minimum amount of water defining a dry cell (in feet)
	APSD	ε_b is minimum amount of water over a barrier for submergence (in feet)
	DCON1 NVGD 1 MLW	Value to add to water depths to translate them to the model datum which is usually NVGD datum (in feet). Depths are negative, thus a - DCON1 will deepen
	*DMPX	Value of land elevation assigned artificially to areas that will never flood (in feet) control value to cutoff, depth checking within WIFM; i.e., this is the MAX land elevation digitized

* Related to XLAND as follows: DMPX is used in digitizing the grid--XLAND < DMPX defines highest potential flood level elevation.

Card Group (Format)	Variable	Description
4 (8F10.0) (Continued)	ROTA	Angle of x-axis as measured counterclockwise from EAST = 0° (in degrees)
	TPRO	Start of prototype time for beginning of run (i.e., time of day in hours)
	ADV	0--no advective or viscosity terms 1--include advective terms, linearize at boundary 2--include advective terms, use approximation at closed bounds
	VIS	ε--viscosity coefficient multiplier; it is dimensionless and if equal to ϕ omits the viscosity coefficient usually set to 1 for initial runs
Note: XLAND < DMPX defines maximum potential flood level elevation	XLAND 	A value of h (i.e., land or water bottom elevation with respect to NVGD datum); greater than XLAND defines a cell that will never flood (in feet) XLAND > 0
	XSCOUR	A value of h < XSCOUR defines a cell that will never go dry (feet) 0 < XSCOUR
	SMAX	If η > SMAX , cease computation and print η (η is surface elevation) (ft)
	SINIT	Set η = SINIT as initial conditions (normally Q). Note: SINIT = 999 , the code will compute inverted barometer effect (ft)
	DMAXG	Positive bound on maximum total water depth that will be experienced during simulation (in feet) (for control of length of friction table)
	DCON2 NVGD - msl	Value to add to tidal input values to translate them to model datum (NVGD) in feet
	DLIMIT	Negative value serving as an artificial cutoff value on water depths (h) (negative since h < 0) in feet
5 Required (16IS)	MAXTIM	Number to τ's to run simulation
	INTAP	m--save η,u,v on logical unit 1 every mτ -1--no data is saved

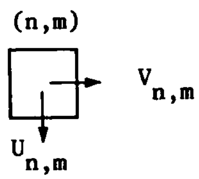
Card Group (Format)	Variable	Description
5 (16I5) (Continued)	IDELAY	Delay saving data on logical unit 1 until ITIME = IDELAY (Note: ITIME counts the number of time steps)
Note: Set these variables to zero; subroutines to accomplish printer plots have been removed from the program, but can be supplied upon District request If these plug controls are set to zero, omit card group 10	IPLOT	≠0--printer plots of elevation hydrographs will be made 0--no plots
	IVPLOT	≠0--printer plots of velocity magnitude hydrographs will be made 0--no plots
	ICPLOT	≠0--printer plots of peak surge elevation along the coast will be made 0--no plots
	IXPAN	≠0--read in variable grid expansion coefficients in card group 6 which will be the output file from program GRID saved on tape 7 0--indicates constant spatial step input this step size in card group 4 in DX and DY variables
	NGAGE	Number of locations where you want data saved, omit card groups 8 and 9 if NGAGE = 0 . Card group 8 is gage locations if NGAGE = 0 , NFREQ = 0
	NFREQ	Frequency to print hydrodynamics at gage points (every NFREQ τ's)
	KREST	Start run at ITIME = KREST. Set to zero except for restart run
	NZP	Number of corrections to input depth grid; omit card group 14 if NZP = 0
	NZQ	Number of corrections to input coded friction grid; omit card group 16 if NZQ = 0
	MDTAP	Logical unit for depth and coded friction input data (normally 5)
	NTABLE	Length of wind input data; i.e., number of entries in the table
	IGLOB	n--save boundary conditions (on logical unit 25) from Global Grid at n points (cells) for later use as forcing conditions to an embedded grid (will need card group 29 to locate indices) 0--no saving for later use

Card Group (Format)		Variable	Description
6 (4G20.11)	Optional	ANG	Dummy variable for the first value of GRID output
This group is created by program GRID on tape 7 and is omitted if IXPAN = 0 or INITL = 1		YNU_i	Expansion coefficients for n-direction (horizontal) of the variable grid = 1, NYY NYY = 2*NMAX (dimensionless)
		XNU_i	Expansion coefficients for vertical direction (indirect) of the variable grid i = 1 , NXX NXX = 2*MMAX (dimensionless)
7 (16I5)	Required	NPRINT	Time step index to print grid an array of 32 elements thus allowing up to 32 printouts (array must be filled, so two cards are required to satisfy the read)
8 (16I5) Omit if NGAGE = 0	Optional	$NPOT_i$	Horizontal indices of locations (i.e. gage) where you want data saved; location is expressed in terms of the horizontal dimension of the grid (N values) i = 1 , NGAGE
		$MPOT_i$	Vertical indices of gage locations (M values) i = 1 , NGAGE
9 (16I5) Omit if NGAGE = 0	Optional	$IGAGE_i$	Codes for methods of computing flows at gage points i = 1, NGAGE

$\bar{\bar{v}} = \frac{1}{4} (V_{n,m} + V_{n-1,m} + V_{n,m+1} + V_{n=1,m+1})$

$\bar{\bar{u}} = \frac{1}{4} (U_{n,m} + U_{n,m-1} + U_{n+1,m} + V_{n+1,m-1})$

$\bar{u} = \frac{1}{2} (U_{n,m} + U_{n,m-1})$



$\bar{v} = \frac{1}{2} (V_{n,m} + V_{n-1,m})$

1--u,$\bar{\bar{v}}$

2--$\bar{\bar{u}}$,v

3--$\bar{\bar{u}}$,$\bar{\bar{v}}$ default $\left\{ \begin{array}{l} \bar{\bar{v}} = \text{4pt avg of v at u)} \\ \bar{\bar{u}} = \text{4 pt avg u at v} \end{array} \right.$

4--u,v

5--u

6--v

7--$\bar{u}$

8--$\bar{v}$

Card Group (Format)		Variable	Description
10 (5I5,2F5.0) Omit all if: IPLOT = 0, ICPLOT = 0 and IVPLOT = 0	Optional		These groups are actually three different sets of variables, each set associated with a type of printer plot to control format of plots; variable list and descriptions are not included Subroutines have been removed from the code, but can be supplied upon District request

Card Group (Format)		Variable	Description
10a (16I5)	Optional		IPLOT--controller for elevation hydrographs IVPLOT--controller for velocity magnitude hydrographs ICPLOT--controller for peak surge elevations (along the coast) plot → Ref: card group 5
11 (16F5.2) Omit if WA NE-1 ref group 4	Optional	WAT_i	Variable wind velocity (mph) i = 1 , NWAT, NWAT = THETA (see group 4)
		THT_i	Corresponding wind direction measured from North as THT (deg) i = 1, NWAT
12 (10E8.1)	Required	This card group codes terrain and barrier characteristics. Each variable in this card group has 20 values	
		$XMAN_i$	Manning's coefficient for each code i (i = 1,20) used for defining friction (Note: value of code (1) is used for all water outside the computational boundaries). This array must be ordered in the same manner as the depth zones defined in card group 15. For example--lowest value to highest value of Manning's coupled with depth zones of deep to shallow (i is dimensionless)
		ZB_i	Barrier height for each code i = 1,20 . This array is referenced by card group 17 variable INDX (ft)
		CB_i	Chezy coefficient to approximate a barrier of overtipping for each code i = 1,20 ($\sqrt{g}$, $ft^{1/2}$, sec) $C_b = \frac{1.49}{n_b}(\varepsilon_b)^{1/6}$
		CO_i	Admittance coefficient for overtopping barrier ($\sqrt{g}$, $ft^{1/2}$/sec) usual range (3-5) i = 1,20
		$CAYD_i$	Recession coefficient for draining of flood cell--keyed by friction codes (fraction of water depth to be allowed to drain within one time step) i = 1,20

Card Group (Format)		Variable	Description
12 (10E8.1) (Continued)		CD_i	Admittance coefficient for limiting movement of water onto flood cells--keyed by friction codes ($\sqrt{g}$, $ft^{1/2}/sec$) usual range (3-5) i = 1,20
		$CANPY1_i$ $CANPY_2$	Canopy coefficients for flooding--used to increase Manning's n friction coefficient over heavily vegetated marshes. (C_1 dimensionless) (C_2 is in feet) $\eta_c = \eta_b\left(1 + C_1 e^{-d^2/C_2}\right)$ for $d < 5$ ft Set $C_1 = 0$, and $C_2 = 1$ for nonuse. i = 1,20
13 (10F8.0) Omit only if INITL.EQ.1	Required	TMP_n	Depth grid array; depths at center of each grid cell. For row M of depths n = 1 , NMAX, start a new card for each M : units of measure (ft) negative in sign
13a (16I5)	Optional	Include only if ISAL $\neq$ 0	
		IDEPTH	Number of depth intervals employed to interpolate initial salinity condition based upon depth
		IFIELD	Number of patches in which initial salinity conditions will be input on a cell-by-cell basis
		IZONE	Number of zones in which the initial salinity condition will be a constant
		Include if IDEPTH $\neq$ 0	
13b (16F5.1)	Optional	TMP_N	Salinity initial value array, N = 1 , IDEPTH (ppt)
		D(N,1)	Depth value array, N = 1 , IDEPTH + 1 (ft)
13c (16I5)	Optional	Repeat IFIELD times. Include only if IFIELD $\neq$ 0	
		NL	Lower horizontal limit of patch i (n-coordinate of cell)
		NU	Upper horizontal limit of patch i (n-coordinate of cell)
		ML	Lower vertical limit of patch i (m-coordinate of cell)

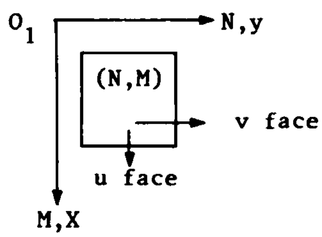
Card Group (Format)		Variable	Description
13c (16I5) (Continued)		MU	Upper vertical limit of patch i (m-coordinate of cell) Repeat (ML - MU) + 1 times
(16F5.1)	CN(N,M),	N = NL,NU	Initial salinity concentration (ppt)
13d Omit only if INITL.EQ.1	Required		Card groups 13d and 13e are ref. Subroutine CONST to read in five different sets of values for the following conditions:
13e			CN--initial salinity values (in ppt) required only for IZONE ≠ 0 CX--dispersion factor in the X-dir (dimensionless) DKXX--dispersion offset in the X-dir (ft^2/sec) CY--dispersion factor in the Y-dir (dimensionless) DKYY--dispersion offset in the Y-dir (ft^2/sec)
		The variables for the card group are:	
(4I5,F10.0)		NZ	Number of zones covering the grid 1st card
(4I5,F10.0)		NL	Lower horizontal index of zone 2nd card
		NU	Upper horizontal index of zone
		ML	Lower vertical index of zone
		MU	Upper vertical index of zone
		R	Value of CN, CX, DKXX, CY, or DKYY to be read in. This is a single value for the set of cells defined N = L,u , M = L,u ; i.e., cells (N,M) where $NL \leq N \leq Nu$ and $ML \leq M \leq Mu$
		Repeat the two cards of this group until all initial condition variables above are satisfied.	
14 (2I5,F5.1)	Optional	N	<u>Corrections</u> to individual cell depths Horizontal index of cell
Omit if NZP.EQ.0 or INITL.EQ.1		M	Vertical index of cell
		DNM	Corrected depth of cell (ft) negative in sign, digitized depth <u>without</u> model datum correction, usually reference is nautical charts, MLW or MLLW Gulf Coast Datum

Card Group (Format)		Variable	Description
15 (35I2)	Required	N	If N = 77 , the next card begins the friction codes for all cells in the grid
Groups 15, 15a, or 15a alternate are required unless INITL = 0			If N ≠ 77 , subroutine FRICTN is called. N is the number of depths used to develop the friction codes and the card which follows begins the definition of depth ranges
		Within SUBROUTINE FRICTN	
15a (8F10.1)	Required	DP_i	Depths to define ranges of depths which correspond to the Manning's n in the XMAN array, used to develop the friction codes (see group 12)
In this group--the scheme operates to assign a Manning's n based on depth			i = 1, ND (Note: N = ND and LE.21)
Omit if INITL.EQ.1			DA's are negative values and must be put in the same relative order as the values of Manning's n in XMAN. (Note: deep to shallow if lowest to highest is the order of Manning's n) (ft)
15a (35I2)	Required	Use this group if SUBROUTINE FRICTN is not used. This alternate group 15a is the friction codes and is related to card group 12 (XMAN)	
In this group the scheme operates to allow you to assign the Manning's n		$ITIDE_M$	This variable is read within a DO LOOP where N = 1,NMAX ... M = 1,MMAX ITIDE is a number for each cell in the grid between 1 and 20 corresponding to the elements of array XMAN which you wish to assign to each cell. The loops operate to assign values by columns
Omit if INITL.EQ.1			
16 (4I5)	Optional		Used for corrections to coded friction grid for individual cells
Omit if NZQ.EQ.0 or INITL.EQ.1		N	Horizontal cell index
		M	Vertical cell index
		MAN(N,M)	Number 1 to 20 to correspond to the elements of array XMAN desired

The code sets up flag areas (internal flags) for each u and v cell face (see diagram following) in the grid based upon depth field and advection code (ADV is set equal to 0, 1, or 2).

Card Group 17 provides for establishing the codes for boundary flags and card group 18 provides for correction to the internal flags.

Card Group (Format)	Variable	Description
17a Required (3I2,6I4) Omit only if INITL.EQ.1	ITYP	Barrier type codes 1--exposed barrier at all times 2--overtopping barrier 4--submerged barrier 8--tidal input 9--flow input 99--exit this group of input, leave remainder of card blank <u>UNLESS</u> you wish to make corrections to the ICU and ICV flag arrays <u>then</u> leave INDX and IDIR blank and set I1 ≠ 0 and include card group 18. It should be set to the number of corrections to be made
	INDX	Value is from 1 to 20, keyed to element of array ZB in card group 12 to set barrier heights if ITYP is set to 1, 2, or 4 For ITYP set to 8, value is from 1 to NTID (NTID is the total number of tidal input signals), i.e., identifies <u>which</u> tidal input For ITYP set to 9, value is from 1 up to NFLD to identify which flow input
	IDIR	1--flow direction is through u cell face 2--flow direction is through v cell face
	I1 I2 I3	Locator grid indices for barrier, tidal input, or flow input For a u face feature: I1 is the row (M) I2 is the beginning column (N) I3 is the ending column (N) For a v face feature: I1 is the column (N) I2 is the beginning row (M) I3 is the ending row (M)



Card Group (Format)		Variable	Description
17a (3I2,6I4) (Continued)		I4	Used with tidal or flow input only, otherwise leave blank 0--input directed toward the right or bottom of the grid 1--input directed toward the left or top of the grid
		I5	When used ITYP = 8 , INDX = 1
		I6	Used for tidal input <u>only</u> when you want to interpolate the values for the tidal input boundary between two tidal signals. I5 and I6 correspond to the two tidal signal numbers; i.e., the elements numbers (of your 2 signals) in the tidal signal arrays IGX and IGY
17b (F8.0) Include if ISAL $\neq$ 0	Optional	XDL	Dispersion coefficient reduction factor for flow restriction (dimensionless)
18 (4I5) Omit <u>unless</u> ITYP.EQ.99.AND.I1.NE.Ø	Optional		Correction codes to ICU, ICV flag arrays. This read statement is in a loop which will execute I1 number of times
		N	Horizontal index of cell
		M	Vertical index of cell
See description at ITYP and INDX codes above			$ICU_{N,M}$--a 2 digit code, n_1n_2 , where n_1 is ITYP and n_2 is INDX of the specific u face of cell (N,M) $ICV_{N,M}$--same except v face condition is described by n_1n_2
19 (4I5,F5.0)	Required		This card group is a special application: NBG--set equal to 0 KSHFT--set equal to 1
		NBG	0--normal -1--no tidal input or discharge, used for storm surge
		KSHFT	Time index unit, where the simulation begins in the boundary input tables; i.e., time step index for beginning of input used with <u>HOTSTART</u> CONDITIONS
20 (4Ab,3F10.0) Omit if NT10 = 0 or NCON = 0 or NBG = -1	Optional (Tidal inputs)	TITLE	Gage title
		TLON	Longitude in degrees of gage
		TM	Time meridian in degrees
		HO	Mean value referenced to model datum

Card Group (Format)		Variable	Description
20a (8F10.0) Use only with 20	Optional	$HM_{j,i}$	Tidal amplitude for each of the tidal constituents j = 1,NCONT (NCONT is the element of the array NCONST which holds the values of the tidal constituents) i = 1,NTID (number of tidal inputs) that is, HM is the specific tidal amplitude in feet of each constituent identified by its element number in the array NCONST for each of the distinct tidal inputs
		$KAPPA_{j,i}$	Tidal phases of the constituents as above (in degrees)
20b (15F5.2) These card groups are tidal boundary INPUT, thus omitted if NTID = 0	Optional	SSV_j	Tidal elevation for each time step j = 1,IT (IT = ITID (card group 3) the number of entries in the tidal input table)
		XKQ	Shift in time step units
		ALP	Amplitude multiplication factor

Repeat card group 20b (NTID-NCON) times. Omit if NTID = NCON

NOTE: If you are simulating salinity ISAL.NE.O, you will need the following additional groups repeated (NTID-NCON) times.

20c (15F5.2)		SSV_j	j = 1,IT--specific salinity value for each tidal signal
21a (15F5.2) omit if NFLO = 0 These groups are flow inputs	Optional	SSV_j	Discharge (in cfs) for each time step j = 1,IT where IT = ITID , number of entries in flow input table
		XKQ	Shift in time step units
		ALP	Multiplication factor

Repeat this card group for each flow input

If ISAL.NE.O you will need group 21a repeated for each flow input as well

21b (15F5.2)	Optional	SSV_j	j = 1,IT , specific salinity value for each flow input (NFLO)
22 (F5.0,I5)	Optional		Specify if IFETR $\neq$ 0
		XLEVEL	Feather level for tidal elevation
		NTD	Number of time steps for flow input feathering

Card Group (Format)		Variable	Description

Card Groups 23 and 24 are presently not being utilized. Subroutines have been removed which accomplish range output. Supplied upon request.

Card Group (Format)		Variable	Description
23 (16I5)		JNS	Number of ranges for computing volumetric discharge (if equal to 0 put in a blank card for this group) integrated value
This card group controls range output		JT1	Time index marking beginning of discharge computation (time step)
Omit if INITL = 1		JPER	Period of discharge cycle in time index units (total length of cycles in time steps)
Use a blank if JNS = 0		JDT	Sampling time step in time index units
		JMUL	Number of seconds in sampling period (τ JDT)
		JDELAY	Delay print of special gage data until ITIME = JDELAYS (avoid spinup time computation)
24 (16I5) Omit if JNS = 0	Optional	$JDIR_i$	Direction of flow in discharge range. Coded: 1--vertical direction 2--horizontal direction where i = i,JNS
		JMN_i	Coordinate index of the range line i = 1,JNS
		$JMN1_i$	Range line extends from $JNS1_i$ to $JNS2_i$
		$JMN2_i$	where i = 1,JNS
25 (16I5)	Required	MNPOT	Number of special gage points to be punched and/or plotted for surface elevation data
		MSKP	Frequency to punch surface elevation data (i.e., every MSKP τ's)
		MDLY	Delay punch of surface elevation data (at special gage points) until ITIME = MDLY
		NVELPN	Number of special gage points for punching and/or plotting velocity magnitude
		MVELP	Frequency to punch velocity magnitude data (every MVELP τ's) (τ is time step)
		MVDLY	Delay punch of velocity data until ITIME = MUDLY

These control variables are for tape (punch) or plot output and are output to tape 3. The plotting is automatic. Plot file name must be specified in JCL.

Card Group (Format)		Variable	Description
26 (16I5) Omit if NNPO7.EQ.Ø	Optional	$INPOT_i$	N indices of special gage points for surface elevations data (ref. card group 25) i = 1,NNPOT up to a maximum of 30 pts
		$JMPOT_i$	M indices of same (start a new card) i = 1,NNPOT
27 (16I5) Omit if NVELPN EQ.Ø	Optional	$NVCORD_i$	N indices of special gage points for velocity magnitude data i = 1, NVELPN
		$MVCORD_i$	M indices of same (start new card) i = 1,NVELPN
28 (16I5) Omit if ISURG = 0 (see card group 2)	Optional	$COAST_i$	Indices of open coast cells where i = 1,NMAX for horizontal coastline and i = 1,MMAX for vertical coastline. This information is obtained from program SHORE
29 (16I5) Omit if IGLOB = 0 (see card group 5)	Optional	$IU1_i$	N indices of cells where boundary conditions are to be saved in global grid, i = 1,IGLOB
		$IU2_i$	M indices of same i = 1,IGLOB (start a new card)

APPENDIX C: REFINED GRID INPUT DATA

```
 5234      1. COIRS NOLIST                                                             CAL.699
   5
PASCAGOULA CHANNEL, REFINED GRID
   49   28    0    1    1    3
    1    1 1440       150        100.
    6 1440    0    2   14   43    1   -2   -2   40
    8   40    0
    6    8    9   10   14   18   20   22   24   25   26   27   28    8    9   10
   14   18   20   22   24   25   26   27   28   28   28   28   28   28   28   28
   28   28   28   28   23   25   25   28
    1    1    1    1    1    1    1    1    1    1    1    1    1   49   49   49
   49   49   49   49   49   49   49   49   49    1    2    4    5    6   11   17
   23   26   31   42   45   47   48   49
        60   3333.33    3333.33      32.2      30.25        0        -1        6
         1          1         -1        50        270        0         1        1
         6          1       10 1         0        200        0      -100
 7200   -1 9999    0    0    0    1   11   10    0    0    4    5   21
   1 9494576545          1 6493923479          1 7751450311          1 7167669846
   1.6689094113          1 6265330104          1 5937300599          1 5632285452
   1 3605692510          1 2325162958          1 1103829258          1 0081220366
   .93403567906          .76966911473          .81325206564          .76341685490
   .70526759010          .65426130704          .60906209667          .56892759621
   53305050668           .50087253758          .50039751541          .47999851273
   49955722634           .49921948726          .33262955233          .22463752176
   15375437752           .11664 499345         .10307671099          .59974469869E-01
   .96660267569E-01      .7401-20767386E-01    .12442675360          .16342875600
   21315107189           .27613774160          .35545733252          .45478536162
   .45995377253          .46514004278          .47022630016          .47525455569
   .48022671059          .49514456487          .49000952464          .49482410585
   .49552655541          .50430562667          .44931666349          .40119191553
   .35896551694          .32162783353          .28909659606          .26016844974
   .22060419726          .16757787154          .15992215316          .13669855230
   .11714117187          .10062523665          .10055871021          .10847659210
   .10040324528          .10033123424          .10628032501          .10019848513
   10012169354           .10005349851          .99957077537E-01      .99921217322E-01
   .99656286677E-01      .99732251467E-01      .99729096562E-01      .99666795760E-01
   .99605326139E-01      .99554668312E-01      .99484799581E-01      .99425700702E-01
   .12871130716          .16610354656          .21372546696          .27418243178
   .35073049692          .44736036276          .49528386154          .54768411698
   .60495555616          .66745002915          .73570584445          .61004966806
   .89099789002          .97905829923          1 0747717695          1 1787141350
   1 2914976654          1 4137741592          0.                    0.
   1 5000000000          1.5000000000          1.5000000000          1 5000000000
   1 3735531054          1.2733606586          1 1907629074          1 1214272060
   1.0621959490          1 0104470950          .96581067584          .92590433667
   .99023559427          .65811528180          .62899658469          .80245281452
   .77612509960          .75572762232          .66723062721          .59252047459
   .52696055365          .47456565266          .32671302202          .22827001490
   .16166233416          .11593612371          .10724652232          .99470626270E-01
   .92486518480E-01      .86191765523E-01      .13926691166          .22057062432
   .34567751736          .53493057697          63043946765           .73975273419
   .86442205303          1.6061263571          .96205966162          .95912808707
   .93725253587          .91636263144          .89439192593          .87728123443
   .85297559602          .54142619147          82456586125           80841270451
   .87748562596          .95094511644          1 0285773077          1 1117724560
   1 1995249635          1 2924333686          1 3507083773          1 4945328631
 1440 2880 4320 5760 7200
    3   35   24   33   30   49   49    4   25   49   49
   20   20   25   26   27   23   22   24    6   27    4
```

6.7									
112	157	105	141	152	148	171	142	158	161
167	142	166	172	27	108	160	170	137	201
153									
.01	.011	.012	.013	.014	.015	.016	.017	.018	.019
.02	.021	.022	.023	.024	.025	.026	.027	.028	.029
10.									
4.									
4.									
9.									
.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
.5	.5	5	.5	5	5	.5	5	.5	.5
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.5	.5	.5	.5	.5	.5	.5	5	.5	.5
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APPENDIX D: REFINED GRID OUTPUT DATA

```
INPUT DATA--CARD 1     PASCAGOULA CHANNEL, REFINED GRID

INPUT DATA--CARD   2
    NMAX,MMAX,INITL,IOVER,IFLVL,LEVEL,ISURG,IHOT,IPOND,NCHAN        49   28    0    1    1    3    0    0    0
    ISAL,ISALC,CMAX,XMS              1 1440  150.00  100.00

INPUT DATA--CARD   3
    ITID,JTID,NTID,NFLO,NP1,NP2,NP3,NPR,MPR,MSURF,KS1,KS2,KS3,KS4,KS5,KS6
      6 1440    0    2   14   43    1   -2   -2   60    0    0    0    0    0    0
    NCON    0

INPUT DATA--CARD   4
    TAU,DX,DY,G,ALAT,XI,WA,THETA,EPSD,APSD,CON1,DMPX,ROTA,TPRO,ADV,VIS,XLAND,XSCOUR,SMAX,SINIT,DMAXG,DCON2,DLIMIT
     60.000         3333.3         3333.3         32.200         30.250         0.00000        -1.0000         6.0000
     1.0000         1.0000        -1.0000         50.000         0.00000        0.00000         1.0000         1.0000
     8.0000         1.0000         10.100         0.00000        200.00         0.00000        -100.00

INPUT DATA--CARD   5
    MAXTIM,INTAP,IDELAY,IPLOT,IVPLOT,ICPLOT,IXPAN,NGAGE     ,NFREQ,KREST,NZP,NZO,NDTAP,NTABLE,IGLOB
     7200   -1 9999    0    0    0    1   11   10    0    0    4    5   21    0

INPUT DATA--CARD   6
    EXPANSION WEIGHTS IN X-DIRECTION
      1.4545         1.3907         1.2924         1.1995         1.1118         1.0290         0.95095        0.87749
      0.80841        0.82459        0.84143        0.85898        0.87728        0.89639        0.91636        0.93725
      0.95513        0.98206        1.0061         0.86442        0.73975        0.63044        0.53493        0.34568
      0.22057        0.13867        0.86192E-01    0.92487E-01    0.99471E-01    0.10725        0.11594        0.16166
      0.22827        0.32671        0.47451        0.52896        0.59252        0.66723        0.75573        0.77813
      0.80245        0.82900        0.85812        0.89024        0.92590        0.96581        1.0108         1.0622
      1.1214         1.1908         1.2734         1.3740         1.5000         1.5000         1.5000         1.5000
    EXPANSION WEIGHTS IN Y-DIRECTION
      1.9495         1.8493         1.7751         1.7168         1.6689         1.6285         1.5937         1.5632
      1.3806         1.2325         1.1104         1.0081         0.93404        0.86967        0.81325        0.76342
      0.70527        0.65420        0.60906        0.56893        0.53305        0.50082        0.50040        0.49999
      0.45560        0.45922        0.33263        0.22470        0.15375        0.10648        0.10308        0.99874E-01
      0.96860E-01    0.94016E-01    0.12442        0.16343        0.21315        0.27614        0.35546        0.45479
      0.45999        0.46514        0.47023        0.47525        0.48023        0.48514        0.49001        0.49482
      0.49955        0.50431        0.44932        0.40119        0.35897        0.32183        0.28909        0.26017
      0.22660        0.18758        0.15992        0.13670        0.11714        0.10063        0.10055        0.10048
      0.10040        0.10033        0.10026        0.10019        0.10012        0.10005        0.99987E-01    0.99921E-01
      0.99856E-01    0.99792E-01    0.99729E-01    0.99667E-01    0.99605E-01    0.99545E-01    0.99485E-01    0.99426E-01
      0.12871        0.16611        0.21373        0.27418        0.35073        0.44739        0.49528        0.54768
      0.60496        0.66749        0.73571        0.81005        0.89100        0.97906        1.0748         1.1787
      1.2515         1.4138

INPUT DATA--CARD   7
    NPRINT 1440 2880 4320 5760 7200    0    0    0    0    0    0    0    0    0    0    0
    NPRINT    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

INPUT DATA--CARD   8
    SPECIAL GAGE LOCATIONS
    NPOT    3   35   24   33   30   49   49    4   25   49   49
    MPOT   20   20   25   26   27   23   22   24    6   27    8
```

```
DEFINE FLOW CALCULATION FOR ALL GAGES
 IGAGE     0    0    0    0    0    0    0    0    0    0    0
```

```
INPUT DATA--CARD  11
    VARIABLE WIND DATA
    VELOCITY      9.60  7.30  5.20  7.60  5.80  8.70  4.90  6.50  7.20  8.00  5.50  5.90  7.60  4.60  3.40  6.60
                  6.70  7.40  4.20  5.10  6.70
    DIRECTION     2.76  1.97  2.68  2.25  2.06  2.13  1.73  2.23  1.95  1.90  1.80  2.23  1.82  1.71  4.24  2.83
                  1.92  1.75  2.32  1.20  2.04

INPUT DATA--CARD  12
    FRICTION CODES      0.010   0.011   0.012   0.013   0.014   0.015   0.016   0.017   0.018   0.019
    FRICTION CODES      0.020   0.021   0.022   0.023   0.024   0.025   0.026   0.027   0.028   0.029
    BARRIER HEIGHTS    10.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
    BARRIER HEIGHTS     0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
    BARRIER CHEZYS    4.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
    BARRIER CHEZYS    0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
    OT/BAR-AD COEFF     4.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
    OT/BAR-AD COEFF     0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
    RECESSION COEFF     4.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
    RECESSION COEFF     0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
    FLOOD-AD COEFF      0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500
    FLOOD-AD COEFF      0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500
    CANOPY COEFF 1      0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500
    CANOPY COEFF 1      0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500
    CANOPY COEFF 2      0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500
    CANOPY COEFF 2      0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500   0.500

INPUT DATA--CARD  25

    NNPOT,MSKP,MDLY,NVELPN,MVELP,MVDLY          4   60    0    7   60    0

INPUT DATA--CARD  26

    INPOT AND JMPOT

       4   25   49   49
      24    6   27    8

INPUT DATA--CARD  27

    NVCORD     3   35   24   33   30   48   48

    MVCORD    20   20   25   26   27   23   22


PROGRAM TIDAL HAS CONSTRUCTED THE FOLLOWING ARRAYS

    DEPTH
    MANNING,S N
    ICF FLAG ARRAY
    VECTORS-IFLOOD,IBARR,ITIDE
```

ICF FLAG ARRAY

M N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1010	1010	1010	1010	1010	1010	1010	9170	1010	1010	1010	1010	1010	1010	1010	9270	1010	1010	1010	1010
2	1010	1010	1010	1010	1010	1010	6011	6150	1010	6060	6050	1010	1010	1010	6060	6060	6050	1010	1010	1010
3	1010	1010	1010	1010	1010	6060	6111	6111	6060	6361	6150	1010	1010	1010	6060	6060	6050	1010	1010	1010
4	1010	1010	6060	6262	6262	6363	6362	6362	6363	6361	6150	1010	1010	1010	6060	6060	6050	1010	1010	1010
5	1010	6060	6363	6363	6363	6363	6363	6363	6363	6363	6162	5062	5062	6060	6060	6060	6050	1010	1010	1010
6	7081	6163	6363	6363	6363	6363	6363	6363	6363	6361	6150	1010	1010	6060	6060	6060	6060	6060	6060	6060
7	7081	6163	6363	6363	6363	6363	6363	6363	6363	6361	6150	1010	1010	6060	6060	6060	6060	6060	6060	6060
8	7081	6163	6363	6363	6363	6363	6363	6363	6363	6363	6362	6260	6011	6060	6060	6060	6060	6060	6060	6060
9	7081	6163	6363	6363	6363	6363	6363	6363	6162	6063	6263	6363	6362	6060	6060	6060	6060	6060	6060	6060
10	7081	6163	6363	6363	6363	6363	6363	6361	6111	1160	5062	6163	6363	6060	6060	6060	6060	6060	6060	6060
11	7081	6163	6363	6363	6363	6363	6363	6363	6360	6050	1010	6161	6363	6060	6060	6060	6060	6060	6060	6060
12	7081	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
13	7081	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
14	7061	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
15	7081	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
16	7081	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
17	7081	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
18	7081	6163	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060
19	7081	6163	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060
20	7081	6163	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6050
21	7081	6063	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060
22	7081	5062	6063	6363	6363	6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060
23	1010	1010	5060	6063	6263	6263	6263	6263	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060
24	7081	6050	1010	1160	1162	1162	5062	5062	6063	6263	6263	6263	6263	6060	6060	6060	6060	6060	6060	6060
25	7061	6162	6262	6262	6260	6050	1010	1010	1160	1162	1162	1162	1162	1160	1160	1160	6060	6060	6060	6060
26	7061	6163	6363	6363	6363	6362	6262	6262	6262	6262	6262	6262	6262	6060	6060	6060	6060	6060	6060	6060
27	7081	6062	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6262	6060	6060	6060	6060	6060	6060	6060
28	8171	8171	6171	8171	8171	8171	6171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171

M	N	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1		1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010
2		1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010
3		1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010
4		1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	6060	6050	1010	1010	1010	1010
5		1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	1010	6060	6050	1010	1010	1010	1010
6		6262	6262	6262	6262	6262	6260	6050	1010	1010	1010	1010	1010	1010	6060	6060	6060	6050	1010	1010	1010
7		6363	6363	6363	6363	6363	6363	6362	6262	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6050	1010
8		6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6050	1010
9		6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
10		6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
11		6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
12		6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	5050
13		6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
14		6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
15		6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
16		6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
17		6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
18		6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
19		6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
20		6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
21		6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
22		6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	5050
23		6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
24		6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
25		6363	6363	6363	6363	6363	6363	6363	6363	6060	1160	1160	6060	6060	6060	6060	6060	6060	5060	5060	5060
26		6363	6363	6363	6363	6363	6363	6363	6363	6060	6060	6060	6060	6060	6060	6060	6060	6050	1010	1010	1010
27		6262	6262	6262	6262	6262	6262	6262	6262	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060	6060
28		8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171	8171

M N	41	42	43	44	45	46	47	48	49
1	1010	1010	1010	1010	1010	1010	1010	1010	1010
2	1010	1010	1010	1010	1010	1010	1010	1010	1010
3	1010	1010	1010	1010	1010	1010	1010	1010	1010
4	1010	1010	1010	1010	1010	1010	1010	1010	1010
5	1010	1010	1010	1010	1010	1010	1010	1010	1010
6	1010	1010	1010	1010	1010	1010	1010	1010	1010
7	1010	1010	1010	1010	1010	1010	1010	1010	1010
8	1010	1010	1010	1010	1010	1010	1010	6060	7181
9	6060	6060	6262	6262	6262	6262	6262	6161	7181
10	6060	6060	6363	6363	6363	6363	6363	6161	7181
11	6060	6060	6363	6363	6363	6363	6363	6161	7181
12	6060	6060	6060	6060	6060	6060	6060	6060	7181
13	6060	6060	6060	6060	6060	6060	6060	6060	7181
14	6060	6060	6060	6060	6060	6060	6060	6060	7181
15	6060	6060	6060	6060	6060	6060	6060	6060	7181
16	6060	6060	6060	6060	6060	6060	6060	6060	7181
17	6060	6060	6060	6060	6060	6060	6060	6060	7181
18	6060	6060	6363	6363	6363	6363	6363	6161	7181
19	6060	6060	6363	6363	6363	6363	6363	6161	7181
20	6060	6060	6363	6363	6363	6363	6363	6161	7181
21	6060	6060	6363	6363	6363	6363	6363	6161	7181
22	6060	6060	6363	6363	6363	6363	6363	6161	7181
23	6060	6060	6363	6363	6363	6363	6363	6161	7181
24	6060	6060	6363	6363	6363	6363	6363	6161	7181
25	5060	5060	6063	6263	6263	6263	6263	6061	7181
26	1010	1010	1160	1162	1162	1162	1162	1160	7181
27	6060	6060	6262	6262	6262	6262	6262	6060	7181
28	8171	8171	8171	8171	8171	8171	8171	8171	8171

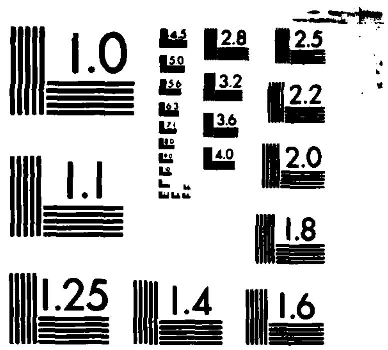
AD-A157 446 USER GUIDE FOR WIFM-SAL (WES IMPLICIT FLOODING MODEL-SAL): A TWO-DIMENSIO..(U) ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MS ENVIR.. R A SCHMALZ 2/2

UNCLASSIFIED MAR 85 WES/IR/EL-85-1 F/G 8/8 NL

END

FILMED

DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

DEPTH--CARD GROUP 13

M	N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1		10.	10.	10.	10.	10.	10.	10.	-19.	10.	10.	10.	10.	10.	10.	10.	-39.	10.	10.	10.	10.
2		10.	10.	10.	10.	10.	10.	-16.	-16.	10.	-3.	-3.	10.	10.	10.	-17.	-39.	-16.	10.	10.	10.
3		10.	10.	10.	10	10.	-4.	-2.	-11.	-2.	-3.	-3.	10.	10.	10.	-17.	-39.	-16.	10	10.	10.
4		10.	10.	-6.	-6.	-3.	-3.	-2	-7.	-2.	-3.	-3.	10.	10.	10.	-31.	-39.	-16.	10.	10.	10.
5		10.	-4.	-8.	-7.	-6.	-5.	-3.	-3.	-3.	-4.	-4.	-4.	-4.	-4.	-20.	-39.	-7.	10	10.	10
6		-4.	-7.	-8.	-7.	-6.	-5.	-3.	-3.	-4.	-4.	-4.	10.	10.	-4.	-9.	-39.	-7.	-7.	-8.	-5.
7		-5.	-8.	-9.	-8.	-7.	-6.	-6.	-6.	-7.	-7.	-6.	10.	10.	-4.	-9.	-39.	-7.	-7.	-7.	-6.
8		-8.	-9.	-9.	-10.	-8.	-7.	-8	-8.	-9.	-9.	-8.	-8.	-8.	-8.	-8.	-39.	-7.	-7.	-7.	-7.
9		-9.	-11.	-12.	-12.	-11.	-9.	-8.	-5.	-7.	-9.	-10.	-10.	-9.	-9.	-8.	-39.	-8.	-7.	-7.	-7.
10		-10.	-12.	-14.	-13.	-13.	-11.	-9.	-7.	-4.	-4.	-6.	-9.	-9.	-9.	-8.	-39.	-9.	-9.	-7.	-7.
11		-11.	-14.	-14.	-14.	-14.	-13.	-12.	-10.	-9.	-4.	10.	-5.	-6.	-7	-10.	-39.	-13.	-9	-7.	-7.
12		-15.	-15.	-15.	-14.	-14.	-13.	-12.	-10.	-9.	-4.	-2.	-3.	-6.	-9.	-11.	-39.	-13.	-9.	-7.	-7.
13		-16.	-16.	-15.	-14.	-14.	-14.	-12.	-10.	-9.	-8.	-3.	-6.	-8.	-10.	-13.	-39.	-13.	-11.	-10.	-10.
14		-17.	-16.	-14.	-14.	-14.	-14.	-13.	-10.	-9.	-8.	-3.	-6.	-8.	-10.	-11.	-39.	-39.	-39.	-39.	-39.
15		-17.	-16.	-14.	-14.	-14.	-14.	-13.	-10.	-9.	-8.	-3.	-6.	-8.	-10	-11.	-11.	-11.	-11.	-11.	-11.
16		-16.	-16.	-15.	-14.	-14.	-14.	-13.	-11.	-9.	-8.	-3.	-8.	-9.	-10.	-11.	-11.	-11.	-11.	-11.	-12.
17		-16.	-16.	-15.	-14.	-14.	-14.	-12	-10.	-9.	-7.	-3.	-8.	-10.	-10.	-11.	-11.	-11.	-11.	-11.	-11.
18		-16.	-16.	-15.	-14.	-14.	-14.	-12.	-10.	-8.	-7.	-5.	-8.	-10.	-10.	-11.	-11.	-11.	-11.	-11.	-11.
19		-15.	-16	-15.	-14.	-11.	-13.	-11.	-10.	-8.	-6.	-8.	-9.	-10.	-11.	-11.	-11.	-11.	-11.	-11.	-12.
20		-15.	-13.	-15.	-13.	-11.	-12.	-12.	-9.	-9.	-7.	-11.	-12.	-13.	-13.	-13.	-13.	-13.	-13.	-14.	-15.
21		-11.	-11.	-14.	-14.	-12.	-10.	-13.	-10.	-11.	-12.	-12.	-12.	-13.	-14.	-14.	-14.	-14.	-14.	-14.	-15.
22		-3.	-7.	-13.	-9.	-10.	-11.	-14.	-15.	-14.	-14.	-14.	-15.	-15.	-16.	-17.	-17.	-17.	-17.	-17.	-18.
23		10.	10.	-13.	-7.	-14.	-10.	-13.	-14.	-14.	-15.	-16.	-17.	-17.	-17.	-17	-17.	-17.	-17.	-17.	-17.
24		-21.	-23.	10.	-11.	-11.	-11.	-13.	-15.	-15.	-17.	-18.	-18.	-17.	-16.	-15.	-15.	-15.	-15.	-14.	-14.
25		-28.	-30.	-26.	-25.	-23.	-25.	10.	10.	-4.	-4.	-6.	-10.	-6.	-11.	-9.	-7.	-7.	-7.	-9.	-9.
26		-36.	-35.	-33.	-33.	-33.	-33.	-29.	-29.	-28.	-29.	-16.	-21.	-21.	-22.	-21.	-21.	-21.	-21.	-21.	-23.
27		-37.	-37.	-39.	-39.	-39.	-39.	-37.	-39.	-36.	-37.	-38.	-36.	-36.	-38.	-34.	-33.	-33.	-33.	-33.	-33.
28		-41.	-41.	-41.	-41.	-41.	-41.	-41	-41.	-41.	-41.	-42.	-43.	-42.	-42.	-41.	-41.	-41.	-41.	-41.	-41.

M	N	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1		10	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.
2		10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.
3		10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10	10.	10
4		10.	10.	10.	10.	10.	10.	10	10.	10.	10.	10.	10.	10.	10.	-16.	-39.	10.	10.	10.	10.
5		10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	-16.	-39.	10.	10.	10.	10
6		-6.	-7.	-7.	-6.	-6.	-6.	-6.	10.	10.	10.	10.	10.	10.	-11.	-16.	-39.	-27.	10.	10.	10.
7		-6.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-39.	-7.	-4.	-3.	10.
8		-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-9.	-8.	-8.	-8.	-8.	-39.	-7.	-5.	-3.	10.
9		-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-8.	-8.	-8.	-8.	-8.	-39.	-7.	-7.	-7.	-7.
10		-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-8.	-8.	-8.	-9.	-9.	-9.	-9.	-39.	-8.	-8.	-8.	-9.
11		-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-8.	-9.	-9.	-10.	-10.	-10.	-10.	-39	-10.	-10.	-10.	-10.
12		-7.	-7.	-8.	-8.	-8.	-8.	-8.	-8.	-8.	-9.	-10.	-11.	-11.	-11.	-11.	-39.	-11.	-11.	-11.	-11.
13		-11.	-11.	-11.	-11.	-11.	-11.	-11.	-11.	-12.	-12.	-13.	-13.	-13.	-13.	-13.	-39.	-14.	-14.	-14.	-14.
14		-39.	-39.	-39.	-39.	-39.	-39.	-39.	-39.	-39.	-39.	-39.	-39.	-39.	-39.	-39.	-39.	-14.	-14.	-14.	-14.
15		-11.	-11.	-11.	-11.	-12.	-11.	-12.	-13.	-13.	-13.	-13.	-13.	-13.	-13.	-13.	-39.	-15.	-15	-15.	-15.
16		-12.	-13.	-14.	-16.	-15.	-15.	-13.	-13.	-13.	-13.	-13.	-13.	-13.	-13.	-13.	-39.	-16.	-16.	-16.	-16.
17		-12.	-13.	-14.	-16.	-15.	-15.	-13.	-13.	-13.	-14.	-14.	-14.	-14.	-15.	-15.	-39.	-16.	-16.	-16.	-16.
18		-12.	-13.	-14.	-16.	-17.	-16.	-16	-15.	-11.	-16.	-16.	-16.	-16.	-17.	-17.	-39.	-17.	-17.	-17.	-17.
19		-13.	-13.	-15.	-15.	-17.	-17.	-17.	-16.	-12.	-17.	-17.	-17.	-17.	-17.	-17.	-39.	-17.	-17.	-17.	-17.
20		-14.	-15.	-15.	-16.	-16.	-17.	-17.	-17.	-17.	-16.	-15.	-16.	-17.	-18.	-19.	-39.	-18.	-18.	-19.	-18.
21		-16.	-17.	-16.	-16.	-17.	-17.	-17.	-17.	-18.	-18.	-15.	-15.	-17.	-19.	-19.	-39.	-19.	-19.	-19.	-19.
22		-17.	-16.	-15.	-16.	-16.	-15.	-17	-16.	-16.	-17.	-17.	-18.	-16.	-18.	-19.	-39.	-19.	-19.	-19.	-21.
23		-17.	-16.	-16.	-14.	-15.	-15.	-16.	-16.	-15.	-15.	-15.	-15.	-16.	-16.	-17.	-39.	-19.	-18.	-18.	-19.
24		-15.	-14.	-13.	-14.	-16.	-19.	-19.	-17.	-16.	-15.	-14.	-16.	-11.	-16	-16.	-39	-17.	-15.	-16.	-16.
25		-8.	-8.	-10.	-13.	-11.	-11.	-12.	-11.	-16.	-16.	-16.	-16.	-19.	-17.	-13.	-39.	-22.	-20.	-20.	-20.
26		-23.	-20.	-20.	-16.	-16.	-14.	-11.	-13.	-15.	-21.	-23.	-26.	-41.	-36.	-50.	-39.	-16.	10.	10.	10.
27		-34.	-34.	-32.	-30.	-28.	-31.	-29.	-19.	-19.	-21.	-21.	-26.	-26.	-26.	-26.	-39.	-21.	-21.	-21.	-21.
28		-36.	-36	-38.	-36.	-38.	-38.	-38.	-34.	-36.	-37.	-37.	-37.	-37.	-37.	-37.	-39.	-37.	-37.	-37.	-37.

M	N	41	42	43	44	45	46	47	48	49
1	1	10.	10.	10.	10.	10.	10.	10.	10.	10.
2		10.	10.	10.	10.	10.	10.	10.	10.	10.
3		10.	10.	10.	10.	10.	10.	10.	10.	10.
4		10.	10.	10.	10.	10.	10.	10.	10	10.
5		10	10	10.	10.	10.	10.	10.	10.	10.
6		10.	10.	10.	10.	10.	10.	10.	10.	10.
7		10.	10.	10.	10.	10.	10.	10.	10.	10.
8		10	10.	10.	10.	10.	10.	10.	-7.	-9.
9		-7.	-6.	-6.	-9.	-4.	-4.	-7.	-9.	-6.
10		-9.	-9	-9.	-9.	-10.	-10.	-11.	-10.	-6.
11		-10.	-12.	-12.	-12.	-13.	-12.	-12.	-10.	-8.
12		-11.	-12.	-14.	-13.	-13.	-14.	-13.	-11.	-8.
13		-14.	-14.	-15.	-14.	-15.	-14.	-13.	-12.	-9.
14		-14.	-14.	-15.	-15.	-15.	-14.	-13.	-12.	-9.
15		-15.	-15.	-15.	-15.	-15.	-14.	-13.	-12.	-9.
16		-16.	-16.	-16.	-16.	-15.	-16.	-14	-13.	-9.
17		-16.	-16.	-16.	-16.	-17.	-16.	-15	-13.	-9.
18		-17.	-17.	-17.	-17.	-17.	-17.	-16	-14.	-10.
19		-18.	-18	-18.	-18.	-18.	-17.	-16.	-15.	-13.
20		-18.	-19.	-19.	-18.	-18.	-18.	-17.	-16.	-15.
21		-19.	-19.	-19.	-18.	-18.	-18.	-17.	-17.	-15.
22		-20.	-20.	-20.	-20.	-20.	-19.	-19.	-18.	-17.
23		-16.	-17	-18.	-17.	-19.	-20.	-19.	-20.	-18.
24		-16.	-16	-15.	-15.	-16.	-17.	-19.	-17.	-20.
25		-20.	-18.	-16.	-12.	-13.	-15.	-11.	-15.	-15.
26		10.	10.	-9.	-9.	-9.	-7.	-11.	-11.	-16.
27		-21.	-21.	-24.	-16.	-16.	-13.	-12.	-13.	-11.
28		-37	-36	-38.	-38.	-39.	-36.	-36.	-35.	-31.

CHEZY COEFFICIENT

M N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0.	0.	0.	0.	0.	0.	0.	243.	0.	0.	0.	0.	0.	0.	0.	274.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	118.	118.	0.	81.	81.	0.	0.	0.	119.	171.	118.	0.	0.	0.
3	0.	0.	0.	0.	0.	85.	76	111.	76.	81.	81.	0.	0.	0.	119.	171.	118.	0.	0.	0
4	0.	0.	96.	96.	81.	81.	76.	98.	76.	81.	81.	0.	0.	0.	155.	171.	118.	0.	0.	0.
5	0.	85.	100.	98.	96.	93.	81.	81.	81.	85.	85.	85.	85	85.	129.	171.	98.	0.	0.	0.
6	85.	98	100.	98.	96.	93.	81.	81.	85.	85.	85.	0.	0.	85.	102.	171.	98.	98.	100.	93.
7	93.	100.	102.	100.	98.	96.	96.	96.	98.	98.	96.	0.	0.	85.	102.	171.	98.	99.	98.	96
8	100.	102.	102.	109.	100.	99.	100.	100.	102	102.	100.	100.	100.	100.	100.	171.	98.	98.	98.	98.
9	102	111.	113.	113.	111.	102.	100.	93.	98.	102.	109.	109	102.	102.	100.	171.	100.	98.	98.	98.
10	109.	113.	116.	114.	114.	111.	102.	98.	85.	85.	96.	102.	102.	102.	100.	171.	102.	102.	98.	98.
11	111.	116.	116.	116.	116.	114.	113.	109.	102.	85.	0.	93.	96.	98.	109	171	114.	102.	98.	98.
12	117.	117.	117.	116.	116.	114.	113	109.	102.	85.	76.	81.	96.	102.	111.	171.	114.	102.	98.	99.
13	118	118.	117.	116.	116.	116.	113.	109.	102.	100.	81.	96.	100.	109.	114.	171.	114.	111.	109.	109.
14	119.	118.	116.	116.	116.	116.	114.	109.	102.	100.	81.	96.	100.	109	111.	171.	171.	171.	171.	171.
15	119.	116.	116.	116.	116.	116.	114.	109.	102.	100.	81.	96.	100.	109.	111.	111.	111.	111.	111.	111.
16	118.	116.	117.	116.	116.	116.	114.	111.	102.	100.	81.	100.	102.	109.	111.	111.	111.	111.	111.	113.
17	118.	116.	117.	116.	116.	116.	113.	109.	102.	98.	81.	100.	109.	109	111.	111	111.	111.	111.	111.
18	118	118	117.	116.	116.	116.	113.	109.	100.	98.	93.	100.	109.	109	111.	111.	111.	111.	111.	111.
19	117.	119.	117.	116.	111.	114.	111.	109.	100.	96.	100.	102.	109.	111.	111.	111.	111.	111.	111.	113.
20	117.	114.	117.	114.	111.	113.	113.	102.	102.	102.	111.	113.	114.	114.	114.	114.	114.	114.	116.	117.
21	111	111	116.	116.	113.	109.	114	109.	111.	113.	113.	113.	114.	116.	116.	116.	116.	116.	116.	118.
22	81.	98.	114.	102.	109.	111.	116.	117.	116.	116.	116.	117.	117.	118.	119.	119.	119.	119.	119.	121.
23	0.	0.	114.	98.	116.	109.	114.	116.	116.	117.	118.	119.	119.	119.	119.	119.	119.	119.	119.	119.
24	130.	132.	0.	111.	111.	111.	114.	117.	117.	119.	121.	121.	119.	118.	117.	117.	117.	117.	116.	116.
25	144.	154.	142.	142.	132.	142.	0.	0.	85.	85.	96.	109.	96.	111.	102.	98.	98.	98.	102.	102.
26	165.	168.	157.	157.	157.	157.	145.	145.	144.	145.	118.	130.	130.	131.	130.	130.	130.	130.	130.	132.
27	170.	170.	171.	171.	171.	171.	170	171.	171.	170.	171.	169.	169.	171.	158.	157.	157.	157.	157.	157.
28	277.	184.	184.	184.	184.	184.	184.	184.	184.	184.	185.	186	185.	185.	184.	184.	184.	184.	184.	184

M N	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.	0.
4	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	118.	171.	0.	0.	0.	0.
5	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	118.	171.	0.	0	0.	0.
6	96.	98.	98.	96.	96.	96.	96.	0.	0.	0.	0.	0.	0.	111.	118.	171.	143.	0.	0.	0.
7	96	98.	98.	98.	98.	98.	98.	98.	98.	98.	98.	98.	98.	98.	98.	171.	98.	85.	81.	0.
8	98.	98.	58.	93.	98.	98.	98.	98.	98.	98.	100.	100.	100.	100	100.	171.	98.	93.	81.	0.
9	98	98.	98.	98.	98.	98.	98.	98.	98.	98.	100.	100.	100.	100.	100.	171.	98.	99.	98.	98.
10	98.	98.	98.	98.	98.	98.	98.	98.	100.	100.	100.	102.	102.	102.	102.	171.	100.	100	100.	100.
11	98	96	98.	98.	98.	98.	98.	96.	100.	102.	102.	109.	109.	109.	109.	171.	109.	109.	109.	109.
12	98.	98.	100.	100.	100.	100.	100.	100.	100.	102.	109.	111	111.	111.	111.	171.	111.	111.	111.	111.
13	111.	111.	111.	111.	111.	111.	111.	111.	113.	113.	114.	114.	114.	114.	114.	171.	116.	116.	116.	116.
14	171.	171.	171.	171.	171.	171.	171.	171.	171.	171.	171.	171.	171.	171.	171.	171.	116.	116.	116.	116.
15	111.	111.	111.	111.	113.	111.	113.	114.	114.	114.	114.	114.	114.	114.	114.	171.	117.	117.	117.	117.
16	113	114.	116.	119.	117.	117.	114.	114.	114.	114.	114.	114.	114.	114.	114.	171.	118.	119.	118.	119.
17	113.	114.	116.	116.	117.	117.	114.	114.	114.	116.	116.	116.	116.	117.	117.	171.	118.	119.	118.	118.
18	113.	114.	116.	11[illegible]	119.	118.	118.	117.	111.	118.	118.	118.	118.	119.	119.	171.	119.	119.	119.	119.
19	114.	114.	117.	117.	119.	119.	115.	118.	113.	119.	119.	119.	119.	119.	119.	171.	119.	119.	119.	119.
20	116.	117.	117.	118.	118.	119.	119.	119.	119.	118.	117.	118.	119.	121.	122.	171.	121.	121.	121.	121.
21	115.	119.	118.	118.	119.	119.	119.	119.	121.	121.	117.	117.	119.	122.	122.	171.	122.	122.	122.	122.
22	119.	118	117.	118.	118.	117.	119.	116.	118.	119.	119.	121.	118.	121.	122.	171.	122.	122.	122.	130.
23	115.	118.	119.	116.	117.	117.	118.	116.	117.	117.	117.	117.	118.	118.	119.	171.	122.	121.	121.	121.
24	117.	116.	114.	116.	118.	122.	122.	119.	118.	117.	116.	118	111.	118.	118.	171.	119.	117.	118.	118.
25	100.	100.	109.	114.	111.	111.	113.	111.	118.	118.	119.	118.	122.	119.	114.	171.	131.	129.	129.	129.
26	132.	129.	129.	121.	116.	116.	111.	114.	117.	130.	132.	142.	184.	169.	204.	171.	118.	0.	0.	0
27	158.	156.	156.	154.	144.	155.	145.	122.	122.	130.	130.	142.	142.	142.	142.	171.	130.	130.	130.	130.
28	169.	169.	171.	171.	171.	171.	171.	158.	169.	170.	170.	170.	170.	170.	170.	171.	170.	170.	170.	170.

INITIAL SALINITY DISTRIBUTION

M	N 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0.	0.	0.	0.	0.	0.	0.	24.	0.	0.	0.	0.	0.	0.	0.	24.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	24.	24.	0.	24.	24.	0.	0.	0.	25.	25.	25.	0.	0.	0.
3	0.	0.	0.	0.	0.	24.	24.	24.	24.	24.	24.	0.	0.	0.	25.	25.	25.	0.	0.	0.
4	0.	0.	24.	24.	24.	24.	24.	24.	24.	24.	24.	0.	0.	0.	26.	26	25.	0.	0.	0.
5	0.	24.	24.	24.	24.	24.	24.	24.	24.	24.	24.	25.	25.	26.	26.	27.	26.	0.	0.	0.
6	24	25.	25.	25.	25.	25.	25.	25.	25.	25.	25.	0.	0.	28.	28.	28.	28.	28.	28.	28.
7	24	25.	25.	25.	25.	25.	26.	26.	26.	27.	27.	0.	0.	27.	27.	28.	28.	28.	28.	28.
8	25.	25.	25.	25.	25.	25.	26.	26.	26.	27.	27.	27.	28.	28.	28.	28.	28.	28.	28.	29.
9	26.	26.	26.	26.	26.	26.	26.	26.	26.	27.	27.	27.	28.	28.	28.	28.	28.	28.	28.	28.
10	26.	26.	26.	26.	27.	27.	27.	27.	27.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.
11	26.	26.	26.	26.	27.	27.	27.	27.	27.	28.	0.	28	28.	28.	28.	28.	28.	28.	28.	28.
12	26	26.	27.	27.	27.	27.	27	27.	27.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.
13	26.	26.	27.	27.	27.	27.	27.	27.	27.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.
14	26.	26.	27.	27.	27.	27.	27.	27.	27.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.
15	26.	26.	27.	27.	27.	27.	27.	27.	27.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.
16	26	26.	27.	27.	27.	27.	27.	27.	27.	28.	29.	28.	28.	28.	28.	28.	28.	28.	28.	28.
17	26	26	27.	27.	27.	27.	27.	27.	27.	28.	28.	28.	28.	28.	28.	28.	28.	28	28.	28.
18	26.	26.	27.	27.	27.	27.	27.	27.	27.	28.	28.	28.	29.	28.	28.	28.	28.	29.	28.	28.
19	27.	26.	27.	27.	27.	27.	27.	27.	27.	28.	28.	28.	28.	28.	28.	28.	28.	29.	28.	28.
20	27.	27.	27.	27.	27.	27.	27.	27.	27.	27.	27.	27.	28.	28.	28.	28.	28.	29.	28.	28.
21	27.	27.	27.	27.	27.	27.	27.	27.	27.	27.	27.	27.	28.	28.	28.	28.	28.	28.	28.	28.
22	27.	27.	27.	27.	27.	27.	27.	27.	27.	27.	27.	27.	28.	28.	28.	28.	28.	29.	28.	28.
23	0.	0.	27.	27.	27.	27.	27.	27.	27.	27.	27.	27.	28.	28.	28.	28.	28.	28.	28.	29.
24	28.	27.	0.	27.	27.	27.	27.	27.	27.	27.	27.	27.	28.	28.	28.	28.	28.	28.	28.	28.
25	28.	28.	27.	27.	27.	27.	0	0.	27.	27.	27.	27.	28.	28	28.	28.	28.	28.	28.	28.
26	28.	28.	27.	27.	27.	27.	28.	26.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.	29.
27	26.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.	29.
28	30.	30.	30.	30.	30.	30.	30.	30.	30.	30.	30.	30.	30.	30	30.	30.	30.	30.	30.	30.

X DISPERSION COEFFICIENT FACTOR

M \ N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0.	0	0.	0.	0.	0.	0.	57.	0.	0.	0.	0.	0.	0.	0.	57.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	2.	57.	0	2.	2.	0.	0.	0.	2.	57.	2.	0.	0.	0.
3	0.	0.	0.	0.	0.	2.	57.	57.	2.	57.	57.	0	0.	0.	57.	57.	57.	0.	0.	0.
4	0.	0.	2.	2.	2.	57.	57.	57.	57.	57.	57.	0.	0.	0.	57.	57	57.	0.	0.	0.
5	0.	2.	57.	57	57.	57.	57.	57.	57.	57.	57.	0.	0.	2.	57.	57.	57.	0.	0.	0.
6	0.	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	0.	0.	57.	57.	57.	57.	2.	2.	2.
7	0.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	0.	0.	57.	57.	57.	57.	57.	57.	57.
8	0.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	2.	2.	57	57.	57.	57.	57.	57.	57.
9	0.	57.	57.	57.	57.	57.	57	57.	57.	2.	2.	57.	57.	57	57	57.	57.	57.	57.	57.
10	0.	57	57.	57.	57.	57.	57.	57.	57.	0.	0.	57.	57.	57.	57.	57.	57.	57.	57.	57.
11	0.	57.	57.	57.	57.	57.	57.	57.	57.	2.	0.	57	57.	57	57.	57.	57.	57.	57.	57.
12	0.	57.	57.	57.	57.	57.	57.	57.	57.	57.	2.	57.	57.	57	57.	57.	57.	57.	57.	57.
13	0.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
14	0.	57.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
15	0.	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
16	0.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.	57.
17	0.	57.	57	57.	57.	57.	57.	57.	57.	57.	57.	57	57.	57	57.	57.	57.	57.	57.	57.
18	0.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.	57.	57.	57.	57	57	57.	57.	57.	57.
19	0.	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
20	0.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
21	0.	2.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
22	0.	0.	2.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57
23	0.	0.	0.	2.	2.	2.	2.	2.	57.	57	57.	57.	57.	57	57.	57.	57.	57.	57.	57.
24	0.	2.	0.	0.	0.	0.	0	0.	2.	2.	2.	2.	2.	2.	2.	2.	57.	57.	57.	57.
25	0.	57.	2.	2.	2.	2.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	57.	57.	57.	57.
26	0.	57.	57.	57.	57.	57.	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.	57.	57.	57.	57.
27	0.	57.	57.	57.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
28	57.	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.	57.	57.	57.

λ DISPERSION COEFFICIENT OFFSET

M N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.
12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0	0.	0.	0.	0.
13	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0	0.	0.
18	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
19	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
20	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
23	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0	0.	0.	0.	0	0.	0.	0.	0.
25	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
26	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
27	0.	0.	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
28	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

Y DISPERSICN COEFFICIENT FACTOR

M	N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	2	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	0.	0.	0.	0.	2.	2.	0.	0.	0.	0.
	3	0.	0.	0.	0.	0.	2.	0.	0.	2.	2.	0.	0.	0.	0.	2.	2.	0.	0.	0.	0.
	4	0.	0.	2.	57.	57.	57.	57.	57.	57.	2.	0.	0.	0.	0.	2.	2.	0.	0.	0.	0.
	5	0	2.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	2	0.	0	0.	0.
	6	57.	57.	57.	57.	57.	57.	57	57.	57.	2.	0.	0.	0.	2.	57.	57.	57.	57.	57.	57.
	7	57.	57.	57.	57.	57.	57.	57.	57.	57.	2.	0.	0.	0.	2.	57.	57.	57.	57.	57.	57.
	8	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	2.	0.	2.	57.	57.	57.	57.	57.	57.
	9	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
	10	57.	57	57.	57.	57.	57.	57	2.	0.	2.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
	11	57.	57.	57.	57.	57.	57.	57.	57.	2.	0.	0.	2.	57.	57.	57.	57.	57.	57.	57.	57.
	12	57	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
	13	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
	14	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57
	15	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.	57.
	16	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
	17	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57	57.	57.	57.	57	57.	57.	57.	57.
	18	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57	57.	57	57.	57	57.	57.	57.	57.
	19	57.	57.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
	20	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57	57.	57	57.	57	57.	57.	57.	57.
	21	57.	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57	57.	57.	57.	57.	57.	57.
	22	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
	23	0.	0.	2.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
	24	57.	0.	0.	2.	57.	57.	57.	57.	57.	57.	57.	57	57.	57	57.	57	57.	57.	57.	57.
	25	57.	57.	57.	57.	2.	0.	0.	0.	2.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
	26	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
	27	57.	57	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
	28	0.	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.	0.

Y DISPERSION COEFFICIENT FACTOR OFFSET

M \ N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.	0.
12	0	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0	0.
13	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
14	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
15	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.
17	0.	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
18	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
19	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.	0.
20	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.	0.
21	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
22	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
23	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
25	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
26	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
27	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
28	0.	0.	0.	0.	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

BARRIER ARRAY.

1	2	1	1	7	2
2	2	1	1	7	3
3	2	1	1	8	3
4	2	1	1	13	6
5	2	1	1	9	10
6	1	1	1	10	10
7	1	1	1	4	24
8	1	1	1	5	24
9	1	1	1	6	24
10	1	1	1	9	25
11	1	1	1	10	25
12	1	1	1	11	25
13	1	1	1	12	25
14	1	1	1	13	25
15	1	1	1	14	25
16	1	1	1	15	25
17	1	1	1	16	25
18	1	1	1	30	25
19	1	1	1	31	25
20	1	1	1	43	26
21	1	1	1	44	26
22	1	1	1	45	26
23	1	1	1	46	26
24	1	1	1	47	26
25	1	1	1	48	26

TIDAL AND DISCHARGE BOUNDARY VECTORS---TRANSMISSION BOUNDARY VECTOR

1	21001006	11008001	0
2	21001007	12016001	0
3	21001008		
4	21001009		
5	21001010		
6	21001011		
7	21001012		
8	21001013		
9	21001014		
10	21001015		
11	21001016		
12	21001017		
13	21001018		
14	21001019		
15	21001020		
16	21001021		
17	21001022		
18	21001024		
19	21001025		
20	21001026		
21	21001027		
22	21001028		
23	121049008		
24	121049009		
25	121049010		
26	121049011		
27	121049012		
28	121049013		
29	121049014		
30	121049015		
31	121049016		
32	121049017		
33	121049018		
34	121049019		
35	121049020		
36	121049021		
37	121049022		
38	121049023		
39	121049024		
40	121049025		
41	121049026		
42	121049027		
43	121049028		
44	111001029		
45	111002028		
46	111003028		
47	111004028		
48	111005028		
49	111006028		
50	111007028		
51	111008028		
52	111009028		
53	111010028		
54	111011028		
55	111012028		
56	111013028		
57	111014028		
58	111015028		
59	111016028		

60	111017028
61	111018028
62	111019028
63	111020028
64	111021028
65	111022028
66	111023028
67	111024028
68	111025028
69	111026028
70	111027028
71	111028028
72	111029028
73	111030028
74	111031028
75	111032028
76	111033028
77	111034028
78	111035028
79	111036028
80	111037028
81	111038028
82	111039028
83	111040028
84	111041028
85	111042028
86	111043028
87	111044028
88	111045028
89	111046028
90	111047028
91	111048028
92	111049028

DISCHARGE FLOWS

1	1152.968	1729.951
61	1151.051	1727.035
121	1149.135	1724.118
181	1147.218	1721.201
241	1145.301	1718.285
301	1143.385	1715.368
361	1141.468	1712.451
421	1139.551	1709.535
481	1137.635	1706.618
541	1135.718	1703.701
601	1133.801	1700.785
661	1131.885	1697.868
721	1129.966	1694.951
781	1128.051	1692.035
841	1126.135	1689.118
901	1124.218	1686.201
961	1122.301	1683.285
1021	1120.385	1680.368
1081	1118.468	1677.451
1141	1116.551	1674.535
1201	1114.635	1671.618
1261	1112.718	1668.701
1321	1110.801	1665.785
1381	1108.885	1662.868
1441	1106.944	1659.976
1501	1106.026	1658.568
1561	1165.067	1657.143
1621	1104.189	1655.726
1681	1163.151	1654.310
1741	1162.192	1652.893
1801	1161.234	1651.476
1861	1100.276	1650.060
1921	1059.317	1648.643
1981	1098.359	1647.226
2041	1097.401	1645.810
2101	1096.442	1644.393
2161	1095.484	1642.976
2221	1094.526	1641.560
2281	1093.567	1640.143
2341	1092.609	1638.726
2401	1091.651	1637.310
2461	1090.692	1635.893
2521	1089.734	1634.476
2581	1088.776	1633.060
2641	1607.817	1631.643
2701	1086.859	1630.226
2761	1055.901	1628.810
2821	1084.942	1627.393
2881	1083.964	1625.946
2941	1081.797	1622.696
3001	1079.631	1619.446
3061	1077.464	1616.196
3121	1075.297	1612.946
3181	1073.131	1609.696
3241	1070.964	1666.446
3301	1069.797	1603.196
3361	1066.631	1599.946
3421	1060.464	1596.696
3481	1062.297	1593.446
3541	1068.131	1590.196
3601	1057.964	1586.946
3661	[illegible]	[illegible]

DISCHARGE SALINITIES

1	0.000	0.000
61	0.000	0.000
121	0.000	0.000
181	0.000	0.000
241	0.000	0.000
301	0.000	0.000
361	0.000	0.000
421	0.000	0.000
481	0.000	0.000
541	0.000	0.000
601	0.000	0.000
661	0.000	0.000
721	0.000	0.000
781	0.000	0.000
841	0.000	0.000
901	0.000	0.000
961	0.000	0.000
1021	0.000	0.000
1081	0.000	0.000
1141	0.000	0.000
1201	0.000	0.000
1261	0.000	0.000
1321	0.000	0.000
1381	0.000	0.000
1441	0.000	0.000
1501	0.000	0.000
1561	0.000	0.000
1621	0.000	0.000
1681	0.000	0.000
1741	0.000	0.000
1801	0.000	0.000
1861	0.000	0.000
1921	0.000	0.000
1981	0.000	0.000
2041	0.000	0.000
2101	0.000	0.000
2161	0.000	0.000
2221	0.000	0.000
2281	0.000	0.000
2341	0.000	0.000
2401	0.000	0.000
2461	0.000	0.000
2521	0.000	0.000
2581	0.000	0.000
2641	0.000	0.000
2701	0.000	0.000
2761	0.000	0.000
2821	0.000	0.000
2881	0.000	0.000
2941	0.000	0.000
3001	0.000	0.000
3061	0.000	0.000
3121	0.000	0.000
3181	0.000	0.000
3241	0.000	0.000
3301	0.000	0.000
3361	0.000	0.000
3421	0.000	0.000
3481	0.000	0.000
3541	0.000	0.000
3601	0.000	0.000
3661	0.000	0.000

1 SALINITY AT T 120 0000 HRS ITIME = 7200

N M	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0	0.	2377	10	0.	2404.	2403.	0.	0.	0.	2879.	2861.	2687.	0.	0.	0.
3	0.	0.	0.	0.	0.	2155.	1640.	276.	2571.	2490.	2405.	0.	0.	0.	827.	853.	1403.	0.	0.	0.
4	0.	0.	2330.	2214.	1914	1253.	1768.	1061.	2480	2474.	2569.	0.	0.	0.	2461.	741.	2183.	0.	0.	0.
5	0.	2409.	2402.	2631.	2475	2417	2671.	1467.	2530	2660.	2663.	2687.	2711.	2518.	2547.	779.	1665.	0.	0.	0.
6	2443.	2440.	2516.	2795.	2794.	2814.	2814.	2778.	2750.	2720.	2565.	0.	0.	2090.	2431.	1994.	2626.	2783.	2800.	2800.
7	2433.	2445.	2577.	2743.	2739.	2758.	2775.	2728.	2693.	2589.	2448.	0.	0.	2102.	2369.	2124.	2479.	2584.	2737.	2735.
8	2422.	2450.	2590.	2740.	2758.	2767.	2769.	2730.	2624.	2432.	2319.	2296.	2279.	2193.	2367.	1956.	1833.	1892.	2383.	2556.
9	2465.	2455.	2629.	2746.	2719	2754.	2777.	2814.	2813.	2714.	2379.	2270.	2265.	2266.	2459.	1897.	1860.	2097.	2172.	2319.
10	2459.	2464.	2700.	2731.	2700	2705.	2746	2807.	2820.	2796.	2791.	2719.	2520.	2344.	2459.	1957.	2044.	2205.	2342.	2468.
11	2545.	2546.	2724.	2712.	2701	2713	2742	2794.	2792.	2740.	0.	2605.	2601	2513.	2405.	2077.	2190.	2298.	2430.	2379.
12	2578.	2554.	2724.	2702.	2702.	2715.	2772.	2826.	2801.	2747.	2726.	2750.	2648.	2516.	2479.	2212.	2249.	2249.	2354.	2377.
13	2558.	2607.	2724.	2699.	2707.	2727.	2751.	2826.	2823.	2783.	2792.	2739.	2739.	2712.	2499.	2259.	2262.	2255.	2296.	2303.
14	2606.	2610.	2724.	2699.	2706.	2725.	2772.	2827.	2805.	2788.	2810.	2740.	2719.	2576.	2379.	2274.	2276.	2267.	2277.	2277.
15	2616.	2614.	2724.	2699.	2706	2727.	2791	2827.	2809.	2802.	2812.	2727.	2707.	2711.	2420.	2264.	2275.	2262.	2310.	2420.
16	2627.	2614.	2724.	2699.	2766.	2729.	2775.	2827.	2810.	2797.	2816.	2751.	2707.	2556.	2364.	2400.	2274.	2306.	2397.	2366.
17	2641.	2623.	2724.	2659.	2709.	2730.	2792.	2826.	2813.	2802.	2819.	2759.	2737.	2703.	2313.	2457.	2407.	2405.	2439.	2499.
18	2684.	2623.	2721.	2699.	2711.	2737.	2789.	2831.	2810.	2815.	2819.	2836.	2838.	2842.	2689.	2650.	2742.	2677.	2797.	2793.
19	2702.	2664.	2718.	2699.	2715.	2751.	2803.	2843.	2811.	2824.	2836.	2859.	2878.	2855.	2827.	2843.	2845.	2839.	2836.	2816.
20	2725.	2706.	2788.	2705.	2721.	2782.	2825.	2851.	2814.	2829.	2838.	2868.	2885.	2879.	2863.	2866.	2856.	2853.	2838.	2828.
21	2658.	2697.	2702.	2705.	2731.	2811.	2836.	2867.	2945.	2894.	2898.	2885.	2892.	2889.	2870.	2867.	2854.	2851.	2840.	2836.
22	2665.	2695.	2702.	2710.	2752	2847.	2864	2860	2878	2915.	2906.	2396.	2918	2891.	2876.	2876.	2870.	2873.	2973.	2993.
23	0.	0.	2702.	2716.	2771.	2876.	2876.	2914.	2923.	2931.	2906.	2910.	2937.	2925.	2918.	2923.	2915.	2918.	2909.	2911.
24	2693.	2701.	0.	2750.	2792.	2874.	2856.	2913.	2943.	2948.	2944.	2931.	2947.	2946.	2950.	2941.	2947.	2939.	2943.	2934.
25	2746.	2792.	2861.	2907.	2835	2873.	0.	0.	2923.	2945.	2953.	2954.	2957.	2956.	2953.	2953.	2956.	2952.	2948.	2937.
26	2772.	2949.	3011.	2930.	2916.	2986.	2946.	2963.	2974.	2977.	2970.	2970.	2971.	2964.	2966.	2967.	2968.	2969.	2968.	2970.
27	2831.	2973.	3015.	3019.	2987.	2986.	2981	2988.	2985.	2978.	2976.	2975.	2982.	2994.	2996.	2996.	2997.	2997.	2997.	3000.
28	3040.	2970.	2998.	3024.	2990.	2992.	2993.	2994.	2991.	2989.	2987.	2980.	2973.	2967.	2964.	2962.	2960.	2960.	2960.	2960.

N N	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0	0.	0	0.	0.	0.	0.	0.	0	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0	0.	0	0	0	0	0	0.	0.	0.	0.	0.	2788.	2800.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2791.	2814.	0.	0.	0.	0.
6	2816.	2804.	2811.	2810.	2806.	2806.	2803.	0.	0.	0.	0.	0.	0.	2772.	2764.	2667.	2860.	0.	0.	0.
7	2814.	2789.	2806.	2805.	2806.	2805.	2801.	2795.	2791.	2786.	2786.	2783.	2784.	2775.	2784.	2749.	2523.	2556.	2556.	0.
8	2757.	2750.	2771.	2763.	2786.	2774.	2763	2757.	2751	2755.	2733.	2764.	2707.	2775.	2659.	2721.	2596.	2606.	2569.	0.
9	2577.	2663.	2746.	2712.	2763.	2785.	2771.	2763.	2763.	2755.	2736.	2697.	2650.	2625.	2605.	2687.	2683.	2633.	2687.	2625.
10	2919.	2515.	2658.	2721.	2755	2764.	2750	2752.	2742.	2734.	2716.	2713.	2673.	2673.	2619.	2665.	2700.	2684.	2670.	2702.
11	2342.	2358.	2475.	2576.	2667.	2698.	2708.	2697.	2659.	2637.	2630.	2626.	2626.	2643.	2634.	2674.	2740.	2749.	2777.	2741.
12	2352.	2349.	2393.	2426.	2530	2634.	2684.	2672.	2645.	2633.	2659.	2672.	2674.	2667.	2659.	2670.	2752.	2751.	2770.	2761.
13	2342.	2421.	2419.	2399.	2463.	2622.	2665.	2661.	2663.	2665.	2669.	2662.	2662.	2671.	2696.	2682.	2787.	2793.	2790.	2786.
14	2294.	2362.	2348.	2323.	2345.	2434.	2577.	2649.	2673.	2675.	2702.	2703.	2698.	2695.	2696.	2665.	2697.	2724.	2750.	2774.
15	2346.	2313.	2378.	2404.	2562.	2634.	2689.	2672.	2686.	2726.	2717.	2704.	2692.	2691.	2689.	2690.	2708.	2707.	2744.	2776.
16	2315.	2367.	2549.	2517.	2621.	2647.	2686.	2655.	2652.	2705.	2731.	2731.	2704.	2687.	2659.	2685.	2694.	2710.	2766.	2762.
17	2476.	2650.	2708.	2682.	2697.	2661.	2672.	2656.	2657.	2660.	2727.	2710.	2782.	2680.	2683.	2700.	2694.	2746.	2777.	2780.
18	2772.	2769.	2748.	2751.	2743.	2718.	2669.	2658.	2671.	2671.	2727.	2713.	2681.	2676.	2680.	2686.	2779.	2798.	2808.	2810.
19	2808.	2760.	2756.	2754.	2736.	2699.	2669.	2673.	2719.	2731.	2707.	2716.	2705.	2687.	2686.	2697.	2793.	2815.	2821.	2822.
20	2811.	2773.	2776.	2757.	2764.	2726.	2706.	2676.	2722.	2747.	2747.	2739.	2729.	2712.	2704.	2703.	2799.	2790.	2816.	2809.
21	2844.	2805.	2822.	2763.	2750.	2726.	2760.	2710.	2711.	2776.	2757.	2773.	2759.	2754.	2745.	2725.	2805.	2744.	2800.	2795.
22	2858.	2816.	2871.	2766.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2743.	2776.	2759.	2757.	2751.	2735.	2812.	2774.	2748.	2743.
23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2789.	[illegible]	2772.	2795.	2794.	2804.	2798.	2791.	2783.	2776.	2772.	[illegible]	2794.	[illegible]	2805.
24	2946.	2946.	2939.	2925.	2961	2693.	2657.	2649.	2766.	2774.	2776.	2769.	2811.	2798.	2807.	2772.	2858.	2842.	2860.	2851.
25	2934.	2931.	2911.	2672.	2734	2692.	2803	2776	2714.	2803.	2805.	2604.	2862.	2882.	2882.	2796.	2867.	2800.	2871.	2869.
26	2561.	3063.	2964.	2961.	2664.	2916.	2627.	2654.	2611.	2755.	2709.	2610.	2820.	2801.	2619.	2823.	2971.	0.	0.	0.
27	2559.	3005.	3086.	3026.	3026.	3042.	3014.	2573.	2513.	2644.	2654.	2666.	2862.	2876.	2896.	2959.	3034.	3034.	3037.	3010.
28	2961.	2961.	[illegible]	2973.	3026.	3057.	3047.	3035	3033.	3029.	3025.	3030.	3034.	3039.	3043.	3047.	3051.	3055.	3059.	3064.

N<N	41	42	43	44	45	46	47	48	49
1	0.	0.	0.	0.	0	0	0	0	0
2	0.	0.	0.	0.	0	0.	0	0.	0
3	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.	0.
7	0	0.	0.	0.	0	0.	0	0.	0
8	0.	0.	0.	0.	0.	0.	0.	2544.	2654.
9	2612.	2615.	2609.	2616.	2552.	2592.	2566.	2665.	2611.
10	2639.	2669.	2626.	2704.	2642.	2712.	2681.	2712.	2698.
11	2761.	2715.	2746.	2759.	2734.	2762.	2737.	2757.	2746.
12	2739.	2750.	2762.	2775.	2746	2763.	2753.	2792.	2786.
13	2777.	2783.	2752.	2779.	2752.	2764.	2771.	2812.	2810.
14	2715.	2786.	2759.	2761.	2753	2767.	2765	2812.	2820.
15	2765	2753.	2747.	2775.	2753.	2761.	2750.	2817.	2820.
16	2795.	2757.	2800.	2767.	2750	2771.	2797.	2816.	2819.
17	2793.	2797.	2800.	2763.	2756.	2778.	2800.	2816.	2810.
18	2818.	2810.	2810.	2757.	2782.	2790.	2807.	2815.	2815.
19	2822.	2824.	2821.	2812.	2795.	2797.	2800	2802.	2704.
20	2821.	2803.	2817.	2813.	2805	2757	2799	2733	2791
21	2806.	2753.	2801.	2802.	2866.	2794.	2801.	2845.	2805.
22	2795.	2793.	2815.	2796.	2800.	2800.	2802.	2811.	2820.
23	2813.	2810.	2831.	2796.	2828.	2797.	2801.	2810.	2820.
24	2859.	2803.	2852.	2823.	2819.	2773.	2801.	2821.	2821.
25	2970.	2866.	2856.	2825.	2794	2761.	2795	2814	2810
26	0.	0.	2892.	2830.	2763	2761	2762	2766	2757
27	3013.	2931.	2967.	2934.	2916.	2828.	2823.	2794.	2793.
28	3068.	3076.	3052.	3017.	2971.	3006.	3046.	3012.	3028.

APPENDIX E: CRAY I-S JOB CONTROL LANGUAGE

```
COESR,T17,I060,STCRA.
ACCOUNT(H48511KV00,921C0933-ACO,ACOCOE,6343809)
JOB,JN=COESR,T=120.
SWITCH,CARET=+.
ACQUIRE,DN=$PL,PDN=SFMSHYDDU,RT=O,MF=I1,UQ,ID=COFHO933.
UPDATE,C=DATA,E,DW=80,IN.
DELETE,DN=$PL,NA.
RELEASE,DN=$PL.
ACQUIRE,DN=$PL,PDN=CLMSHYDPU,RT=O,MF=I1,UQ,ID=COEHO933.
UPDATE,C,F,IN.
DELETE,DN=$PL,NA.
RELEASE,DN=$PL.
AUDIT,PDN=-,ID=COEHO933.
CFT,I=$CPL.
REWIND,DN=DATA.
COPYSBF,I=DATA,O=$OUT.
REWIND,DN=DATA.
ASSIGN,DN=DATA,A=FT05.
LDR,MAP,LIB=DISSPLA.
REWIND,DN=FT07:FT08:FT09:FT10:FT11:FT12.
COPYD,I=FT07.
COPYD,I=FT08.
COPYD,I=FT09.
COPYD,I=FT10.
COPYD,I=FT11.
COPYD,I=FT12.
DISPOSE,DN=FT99,SDN=COETGS1PLOT,ID=COEHO933,DF=SB,DC=ST,WAIT.
DISPOSE,DN=FT25,ID=COEHO933,DC=ST,DF=TR,WAIT,+
TEXT='USERNO,868,XUMPOM.MASS.STORE FT25:TINSH1.'.
DISPOSE,DN=FT35,ID=COEHO933,DC=SI,DF=TR,WAIT,+
TEXT='USERNO,868,XUMPOM.MASS STORE FT35:TINTS1.'.
EXIT.
REWIND,DN=FT07:FT08:FT09:FT10:FT11:FT12.
COPYD,I=FT07.
COPYD,I=FT08.
COPYD,I=FT09.
COPYD,I=FT10.
COPYD,I=FT11.
COPYD,I=FT12.
DISPOSE,DN=FT89,SDN=COETGS1PLOT,ID=COEHO933,DF=SB,DC=ST,WAIT.
DISPOSE,DN=FT25,ID=COEHO933,DC=ST,DF=TR,WAIT,+
TEXT='USERNO,868,XUMPOM.MASS STORE FT25:TINSH1.
DISPOSE,DN=FT35,ID=COEHO933,DC=ST,DF=TR,WAIT,+
TEXT='USERNO,868,XUMPOM.MASS STORE FT35:TINTS1.
```

```
COESR,T17,I060,STCRA.
ACCOUNT(H48511KV00,921C0933-ACO,ACOCOE,6343809)
JOB,JN=COESR,T=820,CL=C.
SWITCH,CARET=+.
ACCESS,DN=FT24,UQ,NA.
ACCESS,DN=FT34,UQ,NA.
DELETE,DN=FT24,NA.
DELETE,DN=FT34,NA.
RELEASE,DN=FT24.
RELEASE,DN=FT34.
ACQUIRE,DN=FT24,ID=COEH0933,RT=0,DF=TR,UQ,+
TEXT='USERNO,868,XUMPOM.MASS.GET FT24:TINSH.'.
ACQUIRE,DN=FT34,ID=COEH0933,RT=0,DF=TR,UQ,+
TEXT ='USERNO,868,XUMPOM.MASS.GET FT34:TINTS.'.
REWIND,DN=FT24:FT34.
ACCESS,DN=DATA,ID=COEH0933,UQ,NA.
DELETE,DN=DATA,NA.
RELEASE,DN=DATA.
ACQUIRE,DN=DATA,ID=COEH0933,RT=0,UQ,+
TEXT='USERNO,868,XUMPOM.MASS.GET DATA:H485TRSD.'.
ACQUIRE,DN=$PL,PDN=CLMSHYDPU,RT=0,MF=I1,UQ,ID=COEH0933.
UPDATE,C,F,IN.
DELETE,DN=$PL,NA.
RELEASE,DN=$PL.
AUDIT,PDN=-,ID=COEH0933.
CFT,I=$CPL,L=0.
REWIND,DN=DATA.
COPYSBF,I=DATA,O=$OUT.
REWIND,DN=DATA.
ASSIGN,DN=DATA,A=FT05.
LDR,MAP,LIB=DISSPLA.
REWIND,DN=FT07:FT08:FT09:FT10:FT11:FT12.
COPYD,I=FT07.
COPYD,I=FT08.
COPYD,I=FT09.
COPYD,I=FT10.
COPYD,I=FT11.
COPYD,I=FT12.
DISPOSE,DN=FT99,SDN=COERTSPLOT,ID=COEH0933,DF=SB,DC=ST,WAIT.
EXIT.
REWIND,DN=FT07:FT08:FT09:FT10:FT11:FT12.
COPYD,I=FT07.
COPYD,I=FT08.
COPYD,I=FT09.
COPYD,I=FT10.
COPYD,I=FT11.
COPYD,I=FT12.
DISPOSE,DN=FT99,SDN=COERTSPLOT,ID=COEH0933,DF=SB,DC=ST,WAIT.
```

END

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DTIC